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SWORDS INTO PLOUGHSHARES

THE British Association was holding its annual meeting in Dundee in 1939 when war was declared. Appropriately enough, the Association is now holding its first full-time post-war meeting in the same city. It was therefore a wise decision on the part of the Council of the Association to arrange that the general theme at the meeting should so far as possible be "Swords into Ploughshares". The contribution of science to human progress is mainly positive and constructive, no matter whether it be fundamental or specifically applied; most men of science would wish that it were completely so. But in warfare of this modern age men of science have their part to play, distasteful though it may prove to be. Yet scientific research carried out as part of the strategy of war almost invariably yields results which, despite the fact that they might be destructive in war-time application, present much useful material and data for the positive pursuits of peace-time. This is well brought out in the addresses of the presidents of the various sections of the Association, but nowhere more so than in Sir Henry Dale's general presidential address entitled "Science in War and Peace" (p. 280).

In facing realities we must agree that the world is not yet at peace, neither is it free from the threat of further conflagration, perhaps even on a world-wide scale. It follows that though every effort towards world peace must be made, it would be foolish during present troublesome times to fall into a state of lethargy and unpreparedness. So some scientific research, especially that dealing with certain aspects of atomic energy, must even now, and perhaps for some time to come, be carried on under the ban of official secrecy. Feeling is high these days, and concern is often expressed that military secrecy might take the place of former industrial interests in slowing up the free flow of ideas which are essential to the smooth progress of scientific endeavour. But at present men of science must face the fact that some secrecy is inevitable, and this makes it all the more imperative, therefore, that they themselves should strive to bring before each other and above all before the general non-scientific public the many beneficent aspects of science. It is doubtful if even men of science themselves fully appreciate the general trend of public opinion concerning science, especially since the advent of the atom bomb. Public opinion, even in high places, if sometimes not well informed, is nevertheless expressed and sometimes acted upon. Some fear that science might become more and more a tool for enforcing one or another political credo and for use in diplomatic intrigue. It is for men of science to prevent this so far as they possibly can. Science must play an important part in international relations; but, at any rate during times of peace, let that be a constructive one. We already have it in the United Nations Food and Agriculture Organisation and it is developing in the United Nations Educational, Scientific and Cultural Organisation.

Yet with all this, opinion is still divided, and even among some scholars and students there are powerful

'anti-science' groups; men who should know better have been heard to express alarm at the march of science and demand the fettering of science and scientific workers. This must not be ignored, and it is therefore best countered by men of science themselves telling the world (so far as they are allowed) of their work, stressing especially the value of their discoveries to man and the profound importance of the impact of science on a modern human society.

Sir Henry Dale, in his presidential address, reiterated the aims of the Association in providing a forum for discussing the interests of science, and its proper place in the life of the community, of the nation and of the world. The word 'proper' is more significant to-day than it has ever been, for there is still much misunderstanding among non-scientific people, even up to the political level, about things scientific. This must be rectified, and it is mainly through such agencies as the British Association and by means of well-documented and written general scientific publications that this can be done.

As Sir Henry said, the concern of science with war was abnormal. Critics tend to forget the conditions under which men of science, like all other members of this and other nations, were working during the War. Most men of science then had a very definite and immediate aim; and all other things were made subservient to that. Working on those projects which aimed at destruction, they were well aware of what they were doing. Sometimes it must have demanded greater courage to carry on research in such circumstances than to abandon it on the grounds of conscience. Those same men of science in days of peace will be able to present their findings to humanity for the good of all; but that depends on national and international goodwill and above all on a true estimate and appreciation of science by the non-scientist. War-time discoveries may be applied, or will certainly lead, to other discoveries which will be for the good of man, finding himself as he does in social conditions becoming more and more affected by scientific achievement.

A week of meetings of the British Association is naturally more than an exposition of recent scientific achievement, though, even if it were narrowed down to this, since such achievement has now to be transferred from war-time use to peace-time applications, there is much work ahead—enough to change the entire pattern of social life, as the examples chosen by Sir Henry Dale serve to show. All listeners to, or readers of, this erudite summary of achievement will be grateful to Sir Henry for a choice wisely made; for no one but the most biased can, after digesting such fare, ignore the inestimable benefits that even war-time science must ultimately bestow on mankind, given the necessary atmosphere of peace and goodwill.

But Sir Henry also issues very pertinent and timely warnings to research workers themselves. For example, the distinction between war-time scientific research (the concentration of nearly all one's thoughts and efforts on practical problems the rapid solution of which was the sole objective) and peace-time research which demands taking a long-range view with the first care of extending fundamental knowledge unconstrained by aim at any practical objective, must be taken to heart by all scientific research workers, especially those of the younger generation who have had their first experience of research work in war-time laboratories.

Older research workers, also, should take to heart Sir Henry's plea that they should not be too ready to assume that their best service to science still lies in planning and organising, or in bringing scientific affairs to bear upon policy. Though in a world of planning men of science must have their say, and in international deliberations, both political and economic, the voice of science must be heard; in other words, though, as *Nature* has frequently demanded, men of science should be consulted and if desirable put into control where matters scientific are concerned, yet a sense of proportion must be brought to bear on this peace-time problem of transition so that it may be realized that the main work of the majority of our men and women of science must be carried out in the laboratories of fundamental research. The main aim must be the advancement of pure knowledge, the search for and exposition of the truth so far as scientific method can elucidate it. The material betterment of man's lot will, in the main, follow from this; in any event it is an ancillary aspect of a very noble calling.

AN ENCYCLOPÆDIA OF HUMAN GENETICS

Human Genetics

By Prof. Reginald Ruggles Gates. Vol. 1. Pp. xvi + 742. Vol. 2. Pp. vi + 743–1,518. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1946.) 2 vols., £3 15*s*. net.

THE role of the gene in the etiology of human defect and derangement is now widely recognized. In the medical curriculum a place for a course of instruction in genetics has been found. The dramatic discovery of the genetic nature of congenital hæmolytic disease has aroused among practitioners of medicine a keen desire to know more about this science, and they are asking for books which will give them the information and the guidance which they seek.

There are elementary text-books of high quality which adequately display and sufficiently illustrate genetic principles. There are monographs which deal with a particular organ, system or clinical entity and include references to most, if not all, instances of relevant genetic abnormality or abnormalities. Twenty-four years ago there appeared the very ambitious treatise of Baur–Fischer–Lenz, which attempted to include between the same covers all instances of genetic defect and derangement affecting each and every system of the human subject; and in 1929 what may be regarded as the forerunner of the book now under review, "Heredity and Man" by Prof. Ruggles Gates, dealing with the whole subject of the special genetics of man. These two did much to attract an interest in genetical science on the part of the anthropologist and the physician.

But developments in medical science and the more recent work on human genetics, together with the exceedingly rapid progress in genetical science generally, have outmoded all books written a decade

or more ago. Teachers of genetics, among many others, have felt the need for an authoritative modern encyclopædic book of reference which would cover the whole field and which would lighten the burden of combing the vast and scattered literature for their illustrations and for the information on which they must base the advice for which they are so commonly approached.

Prof. Ruggles Gates has valiantly attempted to satisfy this need. The result of his long-sustained industry is a book which must attract the respect of all who are in a position to recognize the immensity and the difficulty of the task that he undertook. It is indeed a remarkable, a Herculean, performance. Its magnitude and comprehensiveness can perhaps best be measured by the size of the index, which occupies no less than 90 pages, and by the number of the references, some 5,500, to key papers and books.

As a book of reference these volumes must prove to be of the greatest usefulness. As a collector of pedigrees, Prof. Ruggles Gates must surely be unsurpassed, and to him much gratitude will be attracted through this service which he has rendered during the years of his retirement. But this is meant to be more than a book of reference. It is also a vehicle for the author's interpretation of recorded fact, for his views concerning the nature and cause of genetic phenomena. It is offered therefore as a text-book, and it is as such that its value must be assessed.

Prof. Ruggles Gates is a professional botanist and cytologist of high repute and an anthropologist of standing. He has made notable contributions to the advancement of these sciences. He is among the more prominent of eugenists. But his knowledge of human pathology and of clinical medicine is sufficiently limited to permit him to discuss their contents with an apparent ease which is not displayed by anyone as expert in these fields as is Prof. Gates in his own.

The geneticist with an adequate knowledge of clinical medicine, the medical specialist with a sufficient knowledge of genetics, who turns to this book for guidance based on a critical evaluation of the evidence recorded and dealing with a particular pathological condition in which he happens to be interested, may expect to be surprised, even shocked, by the author's lack of familiarity with the particular subject. How could it be otherwise, for it is highly doubtful if there exists any one man who is competent to deal in this way with the whole of medical genetics or, if it comes to that, with the whole of medicine, which in its growth has become fragmented into a multitude of specialties.

When the author is dealing with matters of which his knowledge has been derived from his own scientific activities, his analyses and summaries are precise, cogent and authoritative. But when he turns, as he commonly must, to matters of which his acquaintance is of the slightest, his commentaries are often hesitant, unsure, sometimes definitely erroneous and occasionally positively misleading.

This book should be regarded as a great storehouse of factual information to be used by such as seek recorded observations concerning the modes of inheritance of human defects and derangements, and as are themselves already competent to make use of what they find. It is for the specialists in the different branches of medicine who already have an understanding of modern genetic theory. As such the book is greatly to be welcomed, and for it the author is to be praised. F. A. E. Crew

MIRACLES

Miracles

A Preliminary Study. By C. S. Lewis. Pp. 220. (London: Geoffrey Bles, 1947.) 10*s.* 6*d.* net.

NOT being a trained historian, Mr. Lewis does not examine the historical evidence for 'miracles'; and having never experienced a 'miracle', he has no direct evidence to offer. But as a student of philosophy, he claims to discuss the previous questions, whether 'miracles' are possible at all, and if so, how probable they are, and how the occurrence of a 'miracle' may be proved. In his last three chapters he applies his reasoning to those miracles, acceptance of which is an article of belief for Christians. He defines a 'miracle' as an interference with Nature by super-natural power. If there is no such power beyond Nature, there can be no miracles. Those who think that nothing exists except Nature hold that Nature somehow maintains itself; though some admit that there was a beginning, and that some day "the clock will run down". The alternative is to regard Nature as derivative from some 'one thing', which is basic and original; which created and maintains; what most people call 'God'. The compromise, an indwelling and emergent God (p. 31)—like the other notion that Nature's elements, indeterminate themselves, conform to the 'law of averages'—does not reveal either basis or origin. The issue, therefore, is between 'naturalism' and supernaturalism.

Mr. Lewis argues that no account of the universe can be true unless it leaves it possible for our thinking to be a real insight. The validity of thought is essential, and it cannot be explained by irrational causes. Whereas Nature is quite powerless to produce rational thought (p. 37)—though it can inhibit it—rational thought enables us to alter the course of Nature, as we constantly and consciously do. Each rational thinker thus is—or includes—something independent of Nature, an "incursion" into Nature of supernatural reality—of a reason which exists absolutely on its own (p. 36), a "principle of organization which impels and develops" (p. 41); and this it can do, because Nature (as Heraclitus said) is "logical and congruous with our minds".

Occasionally, Mr. Lewis seems to make a similar claim for all sentient life (p. 165) and even for vegetable life (p. 135); and as to rational life his argument resembles the old principle *omne vivum e vivo*, which is still for physiologists a fact of observation, however firm their faith that it may be refuted some day.

What is demonstrable thus about logical thinking—about truth in all its forms—is true also about primary moral principles (p. 44). What is in question is not the fact that men make moral judgments, but the rightness of them; and rightness cannot result from non-moral events, any more than truth from irrational. Goodness, like truth, has its basis outside Nature. The same argument might be used about beauty, though Mr. Lewis does not concern himself with this aspect of the supernatural—this quality of the divine.

Thus a 'naturalist', whatever else in Nature he can explain, cannot account for himself, or for mankind, in these essential respects. To Mr. Lewis's argument, he can only oppose his profession of faith: "we do not know yet—but some day we shall—that thought can originate from the thoughtless, and life from the lifeless". This, however, is not science but dogma, and many 'naturalists' merely shelve the question. This inability has escaped notice because

modern concentration on the perception and understanding of Nature by means of reason, without attention to that by which Nature is perceived and understood, has led to the 'naturalist' illusion that there is no such thing. From the special experts in experiment, untrained in logic and metaphysic, Mr. Lewis appeals to the mystics and philosophers of all ages (p. 109); regarding our present predicament as abnormal and perhaps transitory (p. 53).

From this first contention, that human rationality is in itself (by his definition) a 'miracle'—that the supernatural not only exists but also interpenetrates Nature—Mr. Lewis goes on to ask whether there are any other such interventions. At this point, Mr. Lewis's argument passes from general to particular, from the possibility of 'miracles' to the probability of the greater miracles of Christian belief; and inevitably from logic and metaphysic to historical evidence as to times and places. Not being (admittedly) a historian, Mr. Lewis does not see that criticism of one class of 'miracles' must be applicable to all, from the Incarnation, Joshua's prolonged daylight, and the Resurrection, to the 'calm' of Dunkirk. It is this which has made the most expert historians the most cautious in admitting 'miracles'; and they occur most freely in periods when critical skill was least. Christian theology itself, as Mr. Lewis has seen (p. 85), is one long protest against the misinterpretation of symbols inevitably inadequate.

If a 'miraculous' event is unique, as Nature is itself unique, historical proof is almost impossible. Mr. Lewis compares the recovery of a missing episode from a novel or a symphony: if what is found 'makes sense' of the whole composition, its genuineness becomes very probable, and Mr. Lewis devotes the rest of his book to this view. He might have followed the great theologians further. But appropriateness is not proof. JOHN L. MYRES

ONSLAUGHT ON A SUPERSTITION

The Royal Art of Astrology

By Robert Eisler. Pp. 296+17 plates. (London: Herbert Joseph, Ltd., 1946.) 18*s*. net.

FOR the convenience of astrologers "Whitaker's Almanack" for 1947 carefully records the "hour when the Sun enters each Sign of the Zodiac"; Eisler describes in his opening pages how rampant astrology is. He is obviously anxious to destroy this present "stale, superstitious residue", and perhaps his historical survey often forgets his own dictum that this once "glorious philosophical attempt" founded modern astronomy and cosmology (pp. 28, 262). He connects present astrology with "widespread intellectual destitution", and includes with it many pre-critical survivals, such as belief in the "spontaneous generation of life" or in "causes and effects" (pp. 11f, 260f).

Astronomy can forecast an eclipse; astrology can use astronomical calculations, but its own peculiar predictions from horoscopes about the War give Eisler a chance. Italy's entry was not foreseen: an unread message in the stars, however, is less damaging than a message misread. The stars were misread about Sweden, for some astrologers expected Hitler to attack her. Astrologers constantly predicted no war until there was one; then they constantly predicted its end before the finish came. Eisler deduces that modern astrologers try to please their clients by comforting predictions (pp. 21ff). Even if war-time predictions are not fair samples, they are significant. Some astrologers, fairness should add, affirm the old aphorism, the stars incline and do not compel: they impose temperament, not specific destiny. Astrology is vulnerable enough to make undiscriminating arguments unnecessary.

The zodiacal signs cannot derive their astrological significance from accumulated Chaldean and Egyptian experience, Eisler affirms, because they were originally unimportant (pp. 87–110). "Precession" provides "one of the most decisive arguments" against astrology by involving it in absurdities. Eisler notes a typical absurdity "in most modern text-books of astrology". A child born, or conceived, when a certain sector of the zodiac is rising has "Taurine" qualities. Aries is there now, but Taurus was there two thousand years ago, and left his power in it (pp. 110–22).

The stars and planets did inflict one stupendous consequence on men—a medley of beliefs in their presumed effects which determined astrological lore more than sober induction. Eisler uses modern research, the study of old astrological records, for example, to probe the growth of astrology. Inferences about astrological inferences may be mistaken; but Eisler's survey reveals the workings of the human mind and their astrological consequences. His onslaught seems to have precipitate consequences at times. He seems to ignore, for example, that Eudoxus and some others after him regarded the "spheres" as non-physical geometrical conveniences (pp. 33ff). He calls the "hypothetical 'attraction' " of Vitruvius the ancestor of Newton's "mythical 'force' of 'gravitation' ", though Newton did not regard "forces" as actual agents (p. 237).

If Mars derives his astrological reputation from his reddish hue, and Saturn, the "leaden planet", his from his "slow, constant movement", astrology has embodied some wild analogies. It embodies another, if those born under a slowly rising sign live long (pp. 103, 162f, 169). Eisler discusses many wild analogies that have suffused astrology. Imagination has grouped the stars into constellation-pictures, connected them with myths, and drawn astrological deductions. Scorpio, for example, indicates his influence by appearing in the horoscopes of Hitler and Mussolini, though Goethe and Horace had the same ascendant sign (pp. 102f). Historical evidence, Eisler replies to modern defenders, shows that the signs were not named *after* their actual effects had been observed (p. 115).

Tycho Brahe, Eisler says, clung to geocentric astronomy because a central earth is essential to astrological divination (pp. 210, 230). In 1653, Thomas Steele does not fear Copernicanism because astrology can use any valid system of calculation; for an extreme relativist to-day mathematical convenience decides between heliocentrism and geocentrism.

Interesting items include souls and stars, the egregious horoscope of Christ, the "houses" of the planets and the creation of the world, astrological disregard of the velocity of light, the adoption of Uranus as the patron of machinery, and, like odd grains of wheat in much chaff, some actual lunar effects.

There is no index—perhaps because there is so much to compile. The chapter headings, however, are reasonably good guides. Interesting plates and figures are explained in Chapter 33. The last chapter contains a useful bibliography—with comments by the author. JOSHUA C. GREGORY

THEORY OF RADIO ANTENNÆ

Antennæ

An Introduction to their Theory. By J. Aharoni. Pp. viii+266. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 25*s*. net.

THE theory of radio transmitting and receiving aerials is by no means an easy branch of electromagnetism. Aerial theory forms the bridge between the theory of circuits and transmission-lines on one hand and the theory of wave-propagation in space (that is, space more or less free from boundaries) on the other. Aerial theory thus has to face the difficulties of both fields without the simplifications of either. Useful progress largely depends on knowing when, how and how far to permit infiltration of simplifications from both sides. Progress has not therefore been easy, and misunderstandings have been common. However, the widespread development of aerials for radar and radio communication during the War, sometimes along novel lines, has served to clarify the issues involved. The time is therefore ripe for setting down on paper connected accounts of the progress so far made in the development of aerials, and of aerial theory in particular.

This book is, for the most part, a connected account of aerial theory as it had appeared in the technical press before the curtain of war-time secrecy fell. The treatment is mathematical, and the book is scarcely suitable for readers who are not reasonably at home with a mathematical presentation. But the treatment is not academic. What is written seems to have been dictated, not by a desire to do mathematics, but by a desire to describe in mathematical language the basic physics of aerials that should be understood by any radio engineer whose job involves getting down to fundamentals. The book does not deal with elaborate, fancy, or novel aerial systems. It deals almost exclusively with fundamental theories of elementary aerials: the loop, the Hertzian dipole, the half-wave dipole, the full-wave dipole and dipoles of intermediate lengths.

It may be doubted whether the arrangement and subdivision of the book is as good as it might have been. The book is divided into only three chapters, of which the second consists of nearly sixty per cent of the whole. The reader is consequently apt to find that, before he has adequately reflected on one aspect of the subject, he is already engulfed in another. In spite of this, however, the arrangement is not confused, and there is no serious difficulty in finding what one wants from the table of contents. Whether the arrangement adopted places the simplest things first, and whether the approach used is always the simplest available are perhaps matters of opinion.

In each principal aspect of the subject the author has followed fairly closely the original papers that he quotes. For this there is much to be said, though a little more criticism in places would have been welcome. Hallen's treatment of the ends of an aerial is, for example, rather shaky, but the author reproduces Hallen's original argument with apparent confidence. Even so, however, it is very convenient to have Hallen's theory available in this book, since the original paper is in a somewhat inaccessible journal. In addition to Hallen's theory based on an integral equation for the current-distribution, the book includes Schelkernoff's theory based on a wave-guide treatment of the biconical horn, theories dealing with prolate spheroidal conductors, Brillouin's "back E.M.F." method for calculating input-impedance for aerials having prescribed current distributions, as well as the usual treatment of the polar diagram and the radiated power by the Poynting vector method.

Since the author seems to have set out to collect in book form mainly the standard papers on fundamental aerial theory, it would perhaps be unfair to criticize him for making no serious use of the concept of field impedance. Field impedance is equally applicable to transmission lines, to aerials and to wave propagation in space, and so is well suited for integrating all of these phenomena into a single picture. Consideration of field impedance leads one to regard the operation of a straight thin aerial somewhat as follows. Imagine a geometrical cylinder drawn coaxial with the aerial wire and having a radius equal to, say, the geometric mean of the radius and length of the aerial wire. Let this cylinder be terminated by planes through the ends of the aerial perpendicular to the wire, and consider the regions inside and outside the cylinder separately. Outside the cylinder the field may be thought of as that due to a prescribed sinusoidal distribution of current along the aerial wire, and on this basis the field impedance looking normally out of the cylinder may be calculated. Inside the cylinder, the field departs from that due to a sinusoidal distribution of current, especially near the aerial wire itself, and this is how the boundary conditions at the surface of the wire are satisfied. Inside the cylinder the field may be thought of as that in a concentric transmission line the inner conductor of which is the aerial wire and the outer of which is the geometrical cylinder; the impedance per unit length of the outer is that calculated from the field outside the cylinder as already described. This is quite a useful and flexible way of effecting the all-important link between the transmission line approach to aerials and the approach based on a prescribed sinusoidal current-distribution. In particular it explains why, in the conventional application of the back E.M.F. method, it is possible to integrate what is undoubtedly the wrong quantity along the aerial wire and yet get something extraordinarily like the right answer. The integral should in reality be taken along the outer of the concentric transmission line described above, the radius of which tends to zero with the radius of the aerial wire, but more slowly. These points, and others that follow from the same line of argument, are not made in the present book. For this reason it may be doubted whether the book gives a good lead for the future of aerial theory, although it undoubtedly describes the past quite well.

For the future of electromagnetic theory in general there are two respects, however, in which the book does give a good lead. Although the author makes no serious use of field impedance, he not only uses circuit impedance but also gives, early in the book, a better description of what is involved in the concept of reactance than seems to have appeared in any previous book on the theory of the electromagnetic field. In addition, all equations have been written in rationalized universal units (in particular rationalized metre-kilogram-second-coulomb units), thereby facilitating physical and engineering interpretation. Both these features symbolize the complete unification which has been taking place during the past decade, and is still going on, between the theory of electrical circuits (dealing largely with interchange of stored electromagnetic energy) and the theory

of electromagnetic waves (dealing largely with propagation of electromagnetic energy and developed in the first instance particularly for optics). It is a pleasure to see that post-war books on this subject from the Clarendon Press are displaying the new spirit in electromagnetic theory.

To sum up, it may be said that, as a connected account of classical contributions to fundamental aerial theory, the book is well worth reading and well worth keeping to hand. H. G. BOOKER

BRITISH BUTTERFLIES

Butterfly Lives

By S. Beaufoy. Pp. 128. (London: Wm. Collins, Sons and Co., Ltd., 1947.) 12*s.* 6*d.* net.

THIS book of nearly two hundred pictures will give pleasure to many who are interested in animal photography.

Mr. Beaufoy has illustrated, in all stages, twenty-two of the sixty-eight British butterflies, representing every indigenous family, though the distribution of the species selected is rather uneven. Thus there are seven Nymphalidæ, five Pieridæ, five Lycænidæ, but only two Satyridæ: the others are the 'Duke of Burgundy', a 'Skipper', and, of course, the 'Swallow Tail'. We feel that it would have been a more notable feat to show more of the Satyridæ with which the public is less familiar, and omit some of the well-tried favourites.

Dr. Ford points out in his preface that the species are selected to show the characteristics of every indigenous family, and these are indeed brought out. We particularly appreciate the photographs of eggs, of which the shape and sculpture proper to each are beautifully shown. The figures of very young larvæ are a welcome novelty. Most people are familiar with a series of pictures of a butterfly emerging from the chrysalis: less often studied is the remarkable escape of the freshly formed pupa from the hampering larval skin, as shown in a series of six pictures of the small Tortoiseshell at this crisis in its life-history. This seemed to me one of the most instructive series in the book.

Lycænid pupæ are less successfully figured: perhaps a little less magnification would have been better suited to their rather shapeless obesity. On the other hand, the picture of the pupa of the 'Duke of Burgundy' is particularly revealing. The fragrant osmeterium of the larva of the 'Swallow Tail' is well shown.

The letterpress adequately discusses the illustrations, with a few notes on habits, etc.: but the book is, primarily, a picture book. The photographs are certainly "from life", but so is a photograph of a tiger in a cage, and the phrase must not be taken always in its fullest implication. Mr. Beaufoy freely admits that, in photographing butterflies, "really good results, out of doors, are rare", and tells us how, with artificial lighting, he provides "a suitable" setting of foliage or flowers. However, as Mr. Beaufoy's object was "to depict the detailed characteristics of the different species" the question whether, for example, the beautiful picture of the variety of the 'White Admiral' on bramble blossom was taken within or without the studio need not worry us unduly. There can be little doubt about the 'Swallow Tail' feeding from *Buddleia*! Two errors "Aphantophus" (p. 10) and "Lycænidine" (p. 79) should be corrected. G. D. HALE CARPENTER

FIREPROOFING OF FABRICS

The Fireproofing of Fabrics

By J. E. Ramsbottom. Pp. vi+121+11 plates. (Department of Scientific and Industrial Research; H.M. Stationery Office, 1947.) 2*s.* 6*d.* net.

ONE of the major defects of most textile fabrics is their inflammability, and as early as 1638 attention was directed to the use of clay and plaster-of-Paris to reduce the fire risk of canvas used in theatres, while in more recent times the need for fireproofing is periodically emphasized by the comments of coroners on the inflammability of children's flannelette garments. Fireproofing is also of considerable importance to the Services, and in 1930 a preliminary account of investigations carried out at the Royal Aircraft Establishment at Farnborough was given in the second report of the Fabrics Co-ordinating Research Committee.

The present publication is a description of further studies by Dr. Ramsbottom and his colleagues on the subject of fireproofing, together with a new presentation of some of the information given in the earlier report. The object of the investigation was two-fold—to examine the effectiveness of the various fireproofing processes described in the technical and patent literature, and to develop a theory of fireproofing. A treatment which is to be successful commercially should have no adverse effect on the material, and this aspect must be taken into account when assessing the relative merits of various methods. The proofing of kapok, for example—a problem which has been considered in some detail—must not affect the buoyancy of this material. Work of this type has necessitated the development of new methods of experimentation, and the description of these constitutes a valuable guide for other investigators.

The theoretical aspects of fireproofing were first studied by Gay Lussac in 1820, but until recently it was not possible to account for the differences in effectiveness of closely related compounds. As a result of Dr. Ramsbottom's work, however, it may be concluded that fireproofing agents are in general effective because they act as catalysts which modify the changes accompanying the thermal decomposition of cellulose. This hypothesis, which is elaborated in detail for both soluble and insoluble fireproofing agents, will serve as a useful basis for further investigations.

Dr. Ramsbottom's monograph is not a text-book of the usual type—it is primarily an account of his own experimental work—and is written clearly with the detail associated with original contributions. It is authoritative except when dealing with the relative inflammability of various textile materials. This section could with advantage be modified; certainly the term 'artificial silk' should not be used, and some indication should be given of the different fire risks associated with the many types of modern rayons.

Although the booklet does not deal with all aspects of fireproofing, it is an important contribution to the subject and should become a standard work.

A particularly useful feature is a comprehensive list of fireproofing reagents, and the suggestions of the authors as to suitable methods of fireproofing will be of great assistance to practical men called upon to produce fireproof goods. C. S. WHEWELL

Invertase

A Monograph. (Scientific Report Series, No. 4.) By Prof. Carl Neuberg and Dr. Irene S. Roberts. Pp. ix + 62. (New York, 5 : Sugar Research Foundation, Inc., 52 Wall Street, 1946.)

THIS useful monograph on invertase by Prof. C. Neuberg and his daughter, Dr. I. S. Roberts, is a Scientific Report of the Sugar Research Foundation, Inc., of New York. As might be expected from so eminent an investigator as Prof. Neuberg, the monograph gives a succinct and authoritative account of the properties, sources, and modes of preparation of one of the earliest known enzymes. The methods of purification of invertase by adsorption techniques, first used with success by Willstätter, and by precipitation procedures are described in some detail.

Invertase was discovered more than a hundred years ago, and while its study has played an important part in the development of our knowledge of enzymology, its industrial importance, especially in the sugar industry, has not been perhaps so well recognized. Invertase was employed extensively in the preparation of molasses for the supply of sugars to alcohol plants during the times of great urgency when alcohol was required for making synthetic rubber. It plays an important part in the manufacture of confectionery. Biochemists will do well to read this monograph, which summarizes recent literature (405 references) on the subject.

It is unfortunate that the monograph is not entirely free from error. Thus the statement that Quastel and Yates have reported on the inactivating non-reversible influence of both basic and acid dyes is incorrect. These authors (*Enzymologia*, **1**, 60 ; 1936), on the contrary, have shown that both basic and acid dyes combine reversibly with invertase according to mass action laws. In fact, the equilibrium between invertase and acid and basic dyes provides an excellent example of the reversible combination between the ions of an enzyme and those of organic inhibitors such as the dyes. The equilibrium constants of the enzyme–dye combinations were determined, and these results, together with other facts, led Quastel and Yates to the suggestion that invertase acts as a *zwitterion*, the oppositely charged groups of which may be bridged by sucrose when this is present as substrate.

The Soochow Astronomical Chart

By W. Carl Rufus and Hsing Chih Tien. Pp. v + 24 + 2 plates. (Ann Arbor, Mich. : University of Michigan Press ; London : Oxford University Press, 1945.) 14*s*. net.

THIS chart and the text appearing with it constitute instructions for an Emperor and were prepared in A.D. 1193 and engraved in stone in 1247. More than thirty years before they were engraved the capital had been moved from Peking to Kai-Feng Fu, in Honan, but in 1267 Peking was restored as the capital. We are informed in the text that before the Great Absolute had unfolded itself the three primal essences, heaven, earth, and man, were involved within it. The Great Absolute evolves into the sun and the moon, divides into the five planets, arranges in order as the twenty-eight mansions, and meets to form the directors (the Plough) and the circumpolar stars. In the description of the sky the equator is called the Red Road, the ecliptic the Yellow Road, the moon's path the White Road, and the Milky Way the River of Heaven. The planets are the essences of the five elements—wood, fire, earth, metal and water—these elements constituting the planets Jupiter, Mars, Saturn, Venus, and Mercury, respectively. A description of the star map, the purpose of which is astrological rather than astronomical, is given on pp. 8–10. The asterisms follow the traditional oriental pattern—terrestrial beings personified, especially the Emperor, his court, and numerous officials, which differ from the predominant mythical heroes of the West, including supernatural or superhuman personages.

The authors must have spent much time and energy on the production of this work, which will interest all who study the history of ancient constellations.

The Mentally Ill in America

A History of their Care and Treatment from Colonial Times. By Albert Deutsch. Pp. xvii + 530 + 8 plates. (New York : Columbia University Press ; London : Oxford University Press, 1946.) 26*s*. 6*d*. net.

"THE Mentally Ill in America" outlines the history from the earliest times of the attitude towards the insane of their fellow men, particularly in the United States. The author has spent a great deal of time on literary research, and the result has well repaid the time spent. Benjamin Rush, Dorotha Dix and Clifford Beers, names very familiar to English-speaking psychiatrists and others concerned in the care and treatment of the mentally sick, come in for prominent mention, as well they deserve. The detail given is extraordinary and makes a fascinating study ; but the author presents mental hygiene with a stupendous task when he posits the goal toward which mental hygiene must strive as "a world of peace and freedom, from which the twin specters of war and insecurity will be banished, a world of equal opportunity, where people will be freed from stunting inhibitions and guilt feelings arising from outworn prejudices and taboos. . . ." What an objective, and how hopeless it seems in the present state of society the world over ! G. W. T. H. FLEMING

A New Arithmetic

By A. W. Siddons, K. S. Snell and E. H. Lockwood. Part 1. Pp. vii + 184. 2*s*. 9*d*. Part 2, including Numerical Trigonometry. Pp. viii + 210. 3*s*. Part 3, including Numerical Trigonometry. Pp. vii + 151. 2*s*. 9*d*. Notes and Answers for A New Arithmetic. Pp. ii + 90. 5*s*. (Cambridge : At the University Press, 1947.)

THIS new arithmetic consists of three parts, published separately. Part 1 revises the elementary processes of arithmetic, including mensuration, and includes a chapter on statistical graphs. Part 2 begins with the use of four-figure tables of squares, square roots, reciprocals and logarithms. Through the elements of mensuration it leads to numerical trigonometry. Part 3 is devoted to further work on trigonometry, mensuration, more difficult percentages, compound interest, civic arithmetic, stocks and shares, followed by an introduction to statistics for post-school certificate reading.

Carefully graded sets of examples are provided, together with many revision papers. A commendable feature is the emphasis laid upon the proper use of English in writing out the solutions.

Teachers' editions are published separately for Parts 1 and 2 giving notes and answers ; the latter are not provided in Parts 1 and 2, but are given in Part 3.

SCIENCE IN WAR AND PEACE*

By Sir HENRY DALE, O.M., G.B.E., F.R.S.

THE officers and Council of the British Association have naturally wished that this meeting should take special note of the emergence of science, in Britain as in other countries, from its abnormal concern with war, and its return to the service of peace. To rally and to give direction to the thoughts of the members and of the sectional officers in this general sense, the phrase 'Swords into Ploughshares' was suggested, and adopted by the Council, as a motto for the meeting. Even in its most obvious meaning, of the direct adaptation to peaceful uses of the practical results of researches made to meet the demands of war, or forced into rapid fruition by the heat of its urgency, the metaphor will find abundant application in this week of discussions. Let me choose a few, almost at random, for mention now.

How many decades of research do you suppose, undertaken in response to no stimulus stronger than the desire to add to the resources of peace, would have been acquired for those developments of radar, which were achieved in a few years under the imminent threat and the realized peril of war? It is certain that the scientific activities of peace had never witnessed anything like the intimate collaboration of British and American physicists and engineers, which finally played so important a part in giving full effect to this triumph of science in the service of war.

Aeronautical science, having received a great stimulus in the First World War, and having undergone a steady development in the intervening years, sprang again into a phase of headlong progress under the threat and the experience of the Second World War. Now we wait to see what will be the effects, on speed and safety in peaceful transport, of gas-turbine engines and jet propulsion, of stratosphere flight in pressure cabins, and of the fundamental changes in aircraft design, which are all still under rapid development.

Sir Alexander Fleming had encountered the first evidence for the existence of penicillin and described the general nature of its action in 1929, ten years before the War began; but, during that interval, its interest had remained little more than that of an item in the natural history of moulds and bacteria. Sulphanilamide and its derivatives, meanwhile, had opened a new vista of chemotherapy for the bacterial infections, and gramicidin had provided an example of a natural antiseptic, an 'antibiotic' of practical potentialities; but exploration, in this field also, was to wait for war's demands to give it a full and urgent acceleration. And we cannot doubt that the wider survey by Sir Howard Florey and his team, which led them, in 1939, to take penicillin down from the shelf of sound but unexploited observation, for the new study which brought it so rapidly into practical use, owed some of its stimulus to the gathering menace of war. We may certainly assume that the lavish character of the industrial research and enterprise, which then so quickly overcame the difficulties of manufacturing penicillin on a large scale, was chiefly due to recognition of the part which it would play in the conduct of the War. This industrial production, again, made penicillin, and then several penicillins, more rapidly available for the purely scientific investigation of their structures. Here, again, the conditions of peace have never produced such a remarkable co-operative effort of research as that in which teams of some of the leading chemists of Britain and of the United States pooled their results, solved the difficult structural problem with what, by normal standards, would have been an astonishing rapidity, and even, in the case of one of the penicillins, confirmed by synthesis the structure to which the less-direct evidence had pointed.

French, British and Italian investigations had all contributed to the discoveries which had identified the blood parasites causing the malarial fevers, and revealed the manner of their transmission by mosquitoes, all before the present century began. Little more than detailed advance, on the other hand, had been made in the curative or preventive treatment of malaria by medicines since the seventeenth century. Cinchona and its chief alkaloid, quinine, had continued to provide the standard medicinal treatment, although, between the Wars, the research enterprise of German industry had produced two new artificial remedies. One of these, indeed, known as atebrine, and later in Britain as mepacrine, was understood to be comparable in action to quinine, though there had been no sufficient inducement to its extensive trial as a substitute. It was fortunate, then, that, as a military precaution, the effective manufacture of mepacrine had been undertaken in Britain, and then in the United States, before Japan seized, in the East Indies, the source of most of the world's supply of quinine. Under the continued stimulus of war's demand, again, a new campaign of chemotherapeutic research was opened in both Britain and the United States, to seek yet better remedies than quinine or mepacrine. Again there was a co-operative exchange of information and materials between the workers in both countries, and the investigation was conducted on such a scale and with such organisation of effort as had never been contemplated in peace. In a surprisingly short time came reports of new lines of development showing great promise; and a British one of these has culminated, so far, in the discovery of paludrine, a synthetic antimalarial substance of a new type, more effective, and at the same time much freer from harmful accessory activity than quinine, or mepacrine, or any other of its predecessors.

The needs of war, again, soon presented to engineering, on one hand, and to physiology and experimental psychology on the other, a group of practical problems arising from the unnatural conditions of physical and mental stress to which men were exposed in the constantly developing machines of modern warfare, as well as from the extremes of climate and the deprivations to which they were subjected by military necessity or accident. The researches which were framed and conducted, in response to these varying demands, have produced a great volume of new knowledge concerning a variety of conditions which favour or hinder the different activities of man's body and mind, and their resistance to the influence of fatigue.

*Substance of the Presidential Address to the British Association for the Advancement of Science delivered at Dundee on August 27.

Not all the uses of war-time discoveries in peace will depend on applications so direct and obvious. There are examples already, and it is most likely that more will appear, of inventions made with no purposes but those of war, which have found peaceful use in directions entirely unforeseen. For example, an artificial chemical substance, di-isopropylfluorophosphonate, now commonly known as D.F.P., was first made and studied in Britain, as an active member of a poisonous series, known to be under trial in Germany as potential weapons of chemical warfare. The actions of D.F.P., some of them unpleasant enough, were found by workers in Britain, whose results were later confirmed by colleagues in the United States, to be due to its power of annulling the action of cholinesterase—an enzyme widely distributed in the animal body, and playing an important part in relation to the transmission of a number of nervous effects. D.F.P. was never used, in fact, as a chemical weapon; but the action which might have led to such employment has already made it, not only a most interesting and valuable tool of physiological research, but also, according to recent news from the United States, an invaluable remedy, when suitably administered, for the dangerous paralysis of the intestine which may follow an operation. So the wheel has come full circle, and the sword, forged as a lethal weapon, finds use, not only as a ploughshare of peaceful research, but even as a shield for threatened lives.

The sectional meetings during the week will certainly have under discussion many more of such direct applications and extensions of discoveries and inventions made in war to the ordinary needs and purposes of peace. These will constitute, however, only a part, and very likely not the most important part, of the incidental and compensating gains of science itself, and of mankind through science, from this participation in the researches required by war. Scientific research may expect to obtain, from inventions thus made for special and quite unrelated purposes, new tools and facilities for the general advancement of natural knowledge over wide ranges. The development of rockets as weapons of extreme range, for example, may provide means for obtaining data of physical conditions, at altitudes from the earth's surface previously far beyond the reach of scientific exploration; and the great advances made in aerial photography will certainly find application for purely scientific surveys of various kinds, over land and sea. And, apart from many and great additions of this kind to the physical and technical resources available to research, there will be lessons to be learned from war's experience of the methods of planning and organising research, of the recruitment of special research teams, of the value, for the rapid attainment of a particular objective, of co-operation on a national and, as in cases which I have quoted, on an international scale.

Scientific method has had new opportunities of demonstrating its value in the range of the so-called 'operational' researches, in which, for the first time in any war, a largely successful effort was made to collect, and to subject to scientific analysis, accurate data of the performance of new weapons, and of the outcome of new methods. All such experiences in war will have left lessons which may have value in peace, to science in the pursuit of its normal objectives, and to the world at large in a new understanding of what science can be expected to do, and of the kind of aid it can offer towards the solution of suitable problems.

While we may well be eager, however, to ensure that science and those who cultivate it should thus retain and exploit the lessons of value which they learned in their service of war, it may be of at least equal importance that they should, with all rapidity and thoroughness, forget others which ought to be discarded. It is scarcely to be doubted that, to many men of science, the War brought opportunities for research under conditions which made it, in various ways, and in spite of the strain and anxiety of the time, more immediately attractive than any that they had previously encountered. Comradeship, effective even across some national boundaries, in work for a great cause, without thought of personal credit or recognition; an escape, perhaps, from indecision concerning the scientific worth or soundness of a line of personally chosen research, and from anxiety as to material resources for its pursuit, into a world of authority and planning, of problems posed by actual emergencies, of practical issues and tangible results, and of facilities without restriction; and a sense withal of high duty performed for the future of his country and of the world, by the use of a man's own special knowledge and skill, and not always without danger—duty as clear and unquestionable as others could only discharge by a sacrifice of all their normal instincts and interests and, for many, of life itself—all these conditions of scientific war service may have given to many a man a different kind of satisfaction from any which had come to him from the normal experience of a man of science in peace.

I suggest that there may be danger to science from a tendency to transfer too easily and completely, to the activities of peace, the attitude to research and the traditions of its conduct which have been acquired during six years of such war experience.

I am not, of course, speaking just now of the perversion of science which war research involves through its particular concern with the means of slaughter and destruction. For the moment I am concerned with the fact that the response to war's demands has led the majority of scientific workers of Great Britain to devote nearly the whole of their thoughts and efforts, during six years or more, to practical problems presented to them for rapid solution. There must, indeed, be many younger men who have had little experience of other kinds of research than that which has been thus directed and restricted to near and practical objectives, and carried out under a pressure of urgency. From Government organisations and industry, awakened by war's experience to a fuller awareness of what science can do for them under such conditions, it is not likely that encouragement will be lacking for a continuation of similar activities into peace. I myself, indeed, have been bringing to your notice the claims of lines of research which had proved fruitful of practical result for the purposes of war, to be continued and developed now, with a new orientation, to serve those proper to peace. I must make it clear, then, that it is far from my intention to suggest a predominance, in the programmes now to be shaped for science, of such transference to peaceful uses of the research enterprises of war and the methods by which they have been conducted.

Does anyone doubt that, to enable science to render its best service to mankind, we need now to take a long-range view and to give our first care to the extension of fundamental knowledge, unconstrained by aim at any practical objective? I am not here

concerned to advocate, or to defend, either of the rival philosophies, postulating the advancement of pure knowledge on one hand, or the material betterment of man's lot in the world on the other, as the ultimate true motive of the scientific effort. I believe that it would be admitted, by partisans of either, that research which seeks only to advance pure knowledge commonly leads, in the end, to the widest practical developments; and examples are to be found of the contrary, when practical researches are conducted under conditions which leave full freedom to follow fundamental issues, as these present themselves. The concentration, however, of practically the whole of a rapidly growing scientific effort on practical applications and developments, such as the War has witnessed, might find instructive analogy in a rapid and even reckless extension by a commercial undertaking of its trading enterprise, without care to conserve and proportionately to expand its resources of working capital. In theory I think that this is generally recognized, and I am not assuming that any of the different authorities which now provide material support for science in peace will hesitate to give generous encouragement to fundamental researches. My fear is rather that we men of science may find it difficult to shake off quickly the spendthrift habit in research, the policy of trading for quick returns, which six years of war experience may so easily have fostered.

There are other directions in which, I suggest, we should be alert and watchful against too ready an acceptance of lessons learned in war research as applicable directly to the needs of science now. The world never possesses at any time too many men of the highest kind of qualification for research in science—men who, by their own personal effort and achievement, can exert a determinant influence on the rate and the direction of the advance of knowledge into the unknown, and can open new fields of science to detailed exploration by others. There may be men of that type who found that, in the years of war, they could give their best service to science, as well as to the nation and to the cause for which it stood and fought, by organising and planning researches for teams of men with narrower experience and outlook, and by bringing scientific methods to bear on problems of military policy. I believe that scientific services of that kind, rendered in war, have earned far more than they will ever receive in the way of acknowledgment; but I venture to voice a hope that men with the rare, creative ability that science needs now for the resumption of its normal progress, whose influence and example are needed in the schools for the inspiration of those who will follow, will not too readily assume, or too easily be persuaded, that their best service to science will still be rendered by planning and organising, or by bringing scientific ideas to bear upon policy. Here, again, I believe that, under conditions now to be faced, the building up of our scientific capital of fundamental knowledge by those who have the creative gift should have a prior claim over its practical exploitation and the cultivation of its political influence.

There are many, I think, who will be remembering with me the mood which prevailed among men of science when the First World War ended in 1918; how we looked forward then with eager hope and confidence, ready to write off the losses and delays which those four years of war might have inflicted on science, and determined to conserve for it all that could be counted as gain. The role of science in that War had, indeed, been relatively small. For the general body of men of science it had begun on a basis of opportunist intervention or response to special appeal, to deal with emergencies as these arose, the country's scientific reserves being called upon tardily and never completely enrolled. And, when victory came in 1918, the men of science, with few exceptions, were able quickly to escape from war's abnormal duties and commitments, and to return rejoicing to the free air and the wide horizons of science, as they had known it earlier in peace. Lessons had been learned then, as now; the Government and public opinion had gained a new conception of the support of scientific research as a national investment; but thoughts of war, and of its claims on science, receded rapidly then into the background. And although what was to have been a permanent peace proved, in the event, to be less than two decades of an uneasy armistice, with the shadow of another war then rapidly encroaching, what a wonderful new flowering of science was witnessed in that short interval!

Think of the speed and completeness with which our ideas of the universe of matter, of atoms and of the ultimate, subatomic particles, of elements and their mutability, were then being recast; of the transformation, as rapid and impressive, of conceptions of the life process and its physico-chemical background by the advances then being made in organic and physical chemistry, with biochemistry in ever more intimate alliance with them; of the new worlds of knowledge and ideas which were then being opened by the linking of genetics and nuclear cytology, giving a physical basis to the complexities of heredity; or of the first systematic study of the properties of ultramicroscopic viruses, linking, in a manner still mysterious, the characters of matter in macromolecular solution with those of the smallest living and self-propagating organisms. From all these, and from fundamental advances of comparable rapidity and significance in almost all fields of scientific activity, rich harvests of new development and extension were continuously being reaped, by medicine, agriculture, industry, and all branches of applied science. Never, surely, in all previous history, had science surged forward with such impetus as in that interval of years when, in spite of recurrent economic and international crises, a lasting peace seemed still not beyond hope, and a golden age, for a world entering the scientific era of its history, a not impossible aspiration. And, for science itself, one of the points of brightest hope and encouragement was to be found in the steady rebuilding in that interval, in spite of initial obstacles and discouragements, of a true world community of science.

We know how tragically that interval of optimism and of free progress in science, so rapid and so various, came to an end. We cannot expect or even encourage a quick revival of that earlier mood. We are faced now by the contrast between the parts played by science in the two World Wars. In that from which we recently emerged, science, no longer a mere accessory, has moved right into the centre of the picture; and by a process of which we may, perhaps, find the tentative beginning in 1915, with the first use of chemical warfare as a weapon of mass slaughter and disablement, the belligerent use of science has undergone a rapid transformation, turning it into a weapon and a combatant in itself, released from afar for the undiscriminating infliction of death

and destruction, at rapidly growing ranges and on an ever increasing scale. The atomic bombs on Hiroshima and Nagasaki represent, of course, the proximate peak of this development, so far as it has yet been made known; but nobody can suppose them to be the climax of disastrous achievement, if the nations should persist in the desperate project of using further advances in this, or in any other department of science, to prepare in secret, each to excel or to anticipate others in perfecting the means of annihilation. Does the world need yet to be warned as to the end of such a policy? If so, we men of science must continue, against any reluctance to repeat and to insist, to proclaim the danger, and our hatred of the perversion of science to its creation.

Meanwhile we have our own problem of the effect of such a position on the prospect of science itself. For a devotion so complete to the service of war as that which was given in recent years has involved many men of science during its progress in obligations of secrecy entirely new to their experience; and there are important sections of scientific activity which have not yet been able to escape from these trammels. That concerned with the release of atomic energy, with all the side-issues into new lines of scientific progress which that gigantic war enterprise might have made, and will yet, we hope, make available, provides the most conspicuous case. This might, indeed, be regarded as epitomizing, or presenting, by way of an extreme example, the way in which science in peace may inherit opportunities from developments for which war alone could have set the scale and provided the momentum, and the threat to the freedom of science which may be entailed by the same inheritance. Though the scientific basis for its prediction was available in 1939, before the new War broke out, nothing but war, and the need to anticipate a danger of such magnitude in war, could have brought about an effort on the scale needed to convert the release of atomic energy by a chain-reaction from theory to practical reality in a few years. If peace had remained unbroken, the world might have had to wait for many decades to reach a point of such possibilities, for new departures and rapid advances in a whole range of fundamental sciences. War immensely accelerated the presentation of this opportunity to science; but, in doing so, compromised the peaceful use of it by the hideous threat of its further abuse in war. Science, then, finds itself facing a situation in which hope and frustration contend; the need to make the world safe, and the delay of agreement on the means of doing so, clog wheels of science which should now be turning freely for the enlightenment of mankind and the enrichment of human life, many years, perhaps many decades, before they could have done so if the War had not yet come.

How then are we men of science to deal with such a situation? With unquestioning loyalty to all our obligations—that first and foremost; but then also, I would urge, with a resolute watchfulness against any encroachment, on activities proper to peace, of a secrecy which we accepted as an abnormal condition in war, and with a determined effort to accelerate the liberation of science from its entanglement. In the universities in particular I hope that we shall be able to ensure that the men of science of the near future will grow up, as we their predecessors did, in an atmosphere of scientific freedom, and be ready to accept, in their turn, the duty of standing, at need, in the defence of science in its full integrity. And I hope that we can keep as the constant aim of our endeavour, in spite of all that might excuse discouragement, the revival of an intimate brotherhood of the men of science of all nations, working together in full confidence, once more as a world community.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

EARTH, STARS AND RADIO

DURING the year 1947 we are celebrating in Great Britain two important jubilees, one technological and the other scientific. It was in 1897, fifty years ago, that Marconi, the young Italian inventor, gave a decisive demonstration of 'telegraphy without wires' to Sir William Preece, who was then engineer-in-chief of the British Post Office. It was also in 1897 that the Cambridge professor of experimental physics, Prof. J. J. Thomson, made the first public announcement, at an evening discourse at the Royal Institution, of the existence of the electron as an independent entity. The technological development of radio from those early beginnings has had most important scientific consequences. Correspondingly, the scientific discovery of the electron, although important in the first instance because of its bearing on atomic theory, has had profound technological consequences. Indeed, it is scarcely possible to cite better examples of the mutual influence of fundamental science and technology than the developments which have sprung from those two great events of fifty years ago. These developments form the subject of the presidential address by Sir Edward Appleton to Section A (Physical Sciences).

The progress of radio as an agency for exploring the universe has followed directly from two electronic developments, namely, the thermionic valve and the cathode ray oscillograph. With the thermionic valve it is possible to generate radio waves of almost any wave-length. Moreover, such waves, if sufficiently short, can be emitted or received in any desired direction. It is also possible to arrange that their emission takes place in spurts, or pulses, which can be detected again if the waves are reflected by any natural agency in space. The cathode-ray oscillograph can, on the other hand, be used for the measurement of short radio echo-delay times, and also for the delineation of the wave-form of naturally occurring radio transients.

Using such radio and electronic techniques, the wave-forms of atmospherics, originating in lightning flashes, have been studied in some detail, and instantaneous methods have been developed for finding thunderstorm positions at a distance. Similarly, the use of centimetric wave radar echoes has led to methods of estimating the extent of rainfall areas.

During the War it was discovered that coastal radar stations sometimes received echoes from a ship which had passed well beyond the horizon. The detailed examination of this connexion between

radio and the weather has led to the discovery that the lowest layers of the atmosphere may sometimes bend radio wave tracks with a curvature exceeding that of the earth. Such abnormal refraction is associated with temperature inversions and marked water-vapour lapse-rates.

The use of radio-wave exploration for investigating the electrical state of the upper atmosphere has been the subject of continuous experiment in Britain since 1925. It has been found that the ionosphere is subject to a marked solar control, there being a general waxing and waning of the ionization densities in sympathy with the trend of the sunspot cycle. Transient radio echoes have also been noted from the levels of the lower ionosphere, and these have been traced to reflexions from meteor trails.

Finally, the use of sensitive short-wave receivers has disclosed the terrestrial reception of radio noise from both the sun and the stars. Sunspots are found to be powerful emitters of 5-metre waves, the emission being specially enhanced at times of visual solar flares. A continuous radio noise has also been identified as originating in the Milky Way. It is not yet known whether such galactic radio noise originates in interstellar space or in sunspot regions on the stars themselves.

SCIENCE IN THE COLONIES

AFTER reviewing some of the historical examples of the application of research to Colonial problems, Dr. J. L. Simonsen, president of Section B (Chemistry), emphasizes that only with the help of men of science could many of these be solved. While agriculture must continue to be a main industry of the Colonies, its maximum development will require research of a high order. The Colonies can, however, no longer be regarded solely as prime producers, and the introduction of other industries deriving their raw materials from agriculture will be essential. In 1942 the Colonial Products Research Council was formed to review the field of Colonial raw materials, and by research methods ascertain how fuller use could be made of them.

Large-scale industry based on plant products must look to the most abundant of these, namely, the carbohydrates, starch and sugar, as its raw materials. Starch already finds an extended application in industry, and the methods devised at Birmingham for the separation of its two constituents, amylose and amylopectin, have now rendered these products readily accessible. A detailed survey of the little-known starches of tropical Colonial countries is urgently needed. Although sucrose is the organic chemical produced on the largest scale, it has been little used as an industrial raw material apart from fermentation processes. The sucrose molecule is complex, and rapid progress of research into the production of substances of increased industrial value which is now being carried out in Great Britain and the United States cannot be expected, although some of these have been shown to have useful antifreeze, plastic and chemotherapeutic properties.

Recognition of the importance of microbiology has resulted in the decision of the Colonial Products Research Council to open a Microbiological Research Institute in Trinidad. Among the problems it is hoped to attack are those associated with soil fertility and the control of the Panama disease of bananas.

Synthetic organic chemistry has replaced many drugs previously obtained from plants; but this does not, however, diminish the need for a study by modern technique of the constituents of plants with which medicinal properties have been associated. Furthermore, it has been shown that the botanist can no longer disregard the nature of the chemical constituents in his classification of plants.

The value of improved methods of agriculture and the control of soil erosion will be neutralized if steps are not taken to prevent the large losses of the world's food supply incurred through pest infestation. If the new synthetic insecticides, D.D.T. and 'Gammexans', can be shown to be used with safety on foodstuffs, a weapon will be available which should largely eliminate this destruction by insect attack.

Of even greater importance is the control of two of the foremost insect enemies of man and animals, the mosquito and the tsetse fly. Experience with the new insecticide sprays against the mosquito indicates that the problem is not insoluble, and if by a co-ordinated attack on malaria in conjunction with the use of prophylactics, such as paludrine, meets with success, science will have made an outstanding contribution to Colonial prosperity. The control of tsetse, the transmitter of trypanosomiasis, presents a problem of far greater difficulty. The fly can be killed if brought into contact with insecticides, but it is not yet known how best this can be done. Possibly the use of smoke or smoke bombs from aircraft may be a solution; but the problem must be vigorously attacked on a scale commensurate with its magnitude.

GEOLOGY IN THE DEVELOPMENT OF THE COALFIELDS

IN conformity with the general theme of 'swords into ploughshares', the presidential address to Section C (Geology) by Dr. Murray Macgregor deals with the place of geology in the development of the coalfields. The transference of the coal mines of Britain from private to public ownership has created an entirely new set of conditions, bringing with them their own complexities and hazards and demanding vigilant and unsparing service from all concerned. The unified industry will certainly require the best scientific and technical assistance that the country can give. Scientific research applied to the numerous problems that arise in connexion with the exploitation and utilization of the coal resources of Great Britain must be more directive and more closely integrated than in the past. There are the problems connected with occurrence, distribution, structure and correlation; with vertical and lateral variations in the number and thickness of seams, in the lithology, and in the fossil content; with the size and direction of faults, the amplitude and pitch of folds, the occurrence of suites of contemporaneous igneous rocks and of intrusions, etc. There are the chemical and physico-chemical problems connected with the composition and classification of the coals, and the problems related to their preparation for the market and their economic use.

The fact that the geologist is the first link in this chain of concerted effort is too often overlooked or forgotten, and it must be emphasized that all development schemes, short-term and long-term alike, depend upon a proper and thorough knowledge and

appreciation of the relevant geological conditions. In the new era opening out, the unified coal industry, with all its potentialities and its capacity to quicken or retard the *tempo* of our whole national life, must receive all the assistance that geology can provide in planning ahead, in suggestions for economic working, in interpreting structures, in reading doubtful sequences, etc.

The task of the geologist in the coalfields is to correlate and assess all the information already available, to advise as to future developments, and to follow these up much more closely than it has been possible to do in the past. This cannot be achieved by periodic efforts or by a discontinuous service. Research in the coalfields is not a series of separate *ad hoc* pieces of investigation but a continuous service which requires a full-time staff. It is only in this way that geology can be enabled to take its proper place in the economic life of the country. It is only in this way, too, that the gaps in our knowledge of many aspects of Carboniferous geology can be filled, and a more and more broadly based synthesis built up. The coal-mining industry has now become a national trust, and it is as such that it must be regarded by all; the issues are clear-cut and indeed vital, and it is for geologists to see that geology plays its part in the difficult times ahead.

ZOOLOGISTS IN WAR AND PEACE

DR. EDWARD HINDLE, in the opening remarks of his presidential address to Section D (Zoology), mentioned that in view of the exceptional conditions under which they met, he proposed to devote his address to an account of some of the work in which zoologists had been engaged during the past few years. He first referred to war-time activities and gave a brief account of the application of the principles of animal coloration, known as camouflage, and also of some work on anti-fouling. Special attention was devoted to the contributions of zoologists to the maintenance of our food supplies, without which it is very doubtful whether the country could have been adequately fed. An important section of this work was the protection of our food stocks against animal pests, and mention was made of the work of the Bureau of Animal Population at Oxford on rodent control and the development of the Infestation Division of the Ministry of Food. The activities of the latter were dealt with at some length, since it developed as a direct result of war conditions and was staffed mainly by graduates in zoology.

Various attempts were made during the War to increase food supplies. These included extending the use of unmarketable fish which, in the English Channel alone, resulted in the production of about 1½ tons a week of excellent fish-paste from fish that was formerly wasted. The experiments at Loch Sween (Argyll) on the possibility of raising the fertility of a given area of the sea by the addition of nitrates and phosphates were also considered.

Zoologists took a prominent part in some branches of operational research. In particular, they were closely involved in the practical development of radar in connexion with gun-laying devices for anti-aircraft guns, and the development of 'H_2S', an apparatus used for the localization of targets. Eventually this was fitted in various aircraft, and its use resulted in enemy submarines being brought under control during the first half of 1943. Moreover, they did not become a serious menace again until the invention of the 'Schnorkel' in 1945.

Zoologists were found to be particularly well-fitted to cope with the early difficulties of radar, since by their training they become accustomed to handling large numbers of uncontrollable variables.

Some of the peace-time activities of zoologists were then referred to, with special emphasis on the work of entomologists in checking the serious losses in our agricultural products, stored products, and in the prevention of disease. To take only one item, the loss of grain in India, due to rodents, insects and moulds, has been estimated to amount to 12–15 per cent, and a saving of 10 per cent would be sufficient to prevent a famine. In Africa the Colonial Development Scheme, involving the expenditure of some £24,000,000 in the production of ground-nuts, would mean the use of mechanized agriculture on an unprecedented scale in that continent, and would create conditions favourable to the spread of animal pests and disease. Dr. Hindle expressed the hope that the number of professional biologists employed in this project would be commensurate with this expenditure.

The subject of taxonomy was then discussed, and the increasing difficulty of getting accurate identifications of species. An Empire Biological Service, somewhat analogous to the Fish and Wild Life Service in the United States, was suggested, as this might offer the possibility of establishing a pool of taxonomic specialists who could be attached not only to national and provincial museums in Britain, but also to corresponding institutions in the British Empire. Ultimately, this might be extended on an international basis. Finally, Dr. Hindle stressed the educational value of an academic training in zoology, which was out of all proportion to its economic possibilities; and appealed for a return to a less mechanistic training of the younger generation.

GEOGRAPHY IN WAR AND PEACE

IN her presidential address to Section E (Geography), Prof. E. G. R. Taylor points out that, while everyone admits that 'circumstances of place', that is, geography, are relevant to human history and human affairs, it remains true that geographical circumstances are normally regarded as 'accidents'; and as being, moreover, of so obvious a character that it needs no trained geographer to point them out, much less being such as to deserve analysis in detail. This over-simplified idea of geography, which can be exemplified in the writings of historians, economists, military commentators and others, is responsible for the fact that the subject receives no mention in the schemes for revised university curricula aimed at the provision of a more balanced general education embracing both science and the humanities. Nor is it included in plans for the advancement and endowment of the social sciences. The pure scientist, too, rejects geography since (except in certain limited aspects) it is not susceptible of study by the method of controlled experiment. Yet departments of geography are over-full, and chairs in geography multiply faster than they can be effectively filled. Ordinary people are recognizing that the regional differentiation of the world's surface (although they would not thus define it) lies behind some of our most crucial problems, and is at the root

(for example) of the effective reduction of the number of Great Powers to two.

The causes and consequences of regional differentiation can only be understood in relation to the globe viewed as an organic whole. The concept of 'global thinking' goes back among geographers to the late eighteenth century traveller von Humboldt. As thus envisaged, geography shares with sociology the methodological difficulties arising from the impossibility of isolating 'pure' problems, with the consequent need to call upon a number of diverse skills and specialisms. The present climate of thought is, however, unfavourable to group research (employing specialists from different fields) and even to team research (employing specialists within the same field), and successful examples of such work are few. Nevertheless archæologists, historians, economists, sociologists and physical planners have recently shown an increasing disposition to seek the collaboration or advice of geographers, no doubt because, now that a second generation of trained geographers is coming to maturity, the output of work reaching an acceptable standard of scholarship is increasing. Examples of such work with a particular social bearing include analyses of the geographical circumstances of 'problem' areas—the Italo-Jugoslav boundary, Palestine, the march-lands of Russia, the 'special areas' of Britain—studies in micro-climatology, in coastal morphology, in land-utilization, areas of urban circulation and influence, and so on. The value of maps, not merely as a means of exposition, but also as a tool of research, is also increasingly appreciated.

A world war has for the second time emphasized the need for 'terrain' geography and exposed the gaps in geographical knowledge. New methods of air photography—stereoscopic survey, colour and infra-red photography—are capable of supplying data by which those gaps could be rapidly filled. The interpretation of such data occupied many geographers during the Second World War. Beach reconnaissance, involving a land, sea and air complex, as a preliminary to military landings, called for novel methods of research, and led to new knowledge of shore-line processes and coastal morphology. The use of rockets and unpiloted aeroplanes lends a new importance to exact knowledge of the shape and dimensions of the geoid. The need for popular education in world geography lays upon geographers the duty of designing maps and globes which give a world picture appropriate to an 'air age'.

PROGRESS IN MODERN ENGINEERING

CIVIL engineering aspects of progress in modern engineering is the principal topic of the presidential address to Section G (Engineering) by Sir William Halcrow. An analysis of engineering evolution involves consideration of mental conditioning in the past as well as of achievement. Society as a whole did not become mechanically minded until after the First World War, and the progress was slow. American influence is considerable, and we must understand the conditions which have led to their lavish use of machines and materials. Reference to the progress of prime movers, of constructional materials, and of some recent developments in technique follows.

The steam engine has been highly developed for many years; but the steam railways require considerable improvements to cater for modern traffic intensities. The great operational inflexibility of the system can only be relaxed by changes in track layout, signalling systems and dead weight of stock.

Steam turbines are our main prime mover for the generation of electricity. Fuel ancillaries are inherently heavy and bulky, however, and the gas turbine, which will soon be in economical operation in aircraft, may challenge the steam turbine on these grounds. At present, however, its life is too short for purely industrial purposes.

The water turbine has been highly developed for some considerable time. Intensive hydro-electric development is taking place in the Highlands of Scotland; but the great Severn Barrage tidal scheme still awaits official approval. With 800,000 kW. installed capacity, it could produce some 2,300 million units of electricity per annum at 0·2*d.* per unit and save one million tons of coal a year.

Our mechanical civilization did not attain a high rate of development until the latter half of the nineteenth century, when iron and steel could be produced in large quantities. The present century has seen the great development of alloy steels, and we may be approaching the end of the age of simple mild steel. The use of light alloys has greatly increased, and it is not generally realized that aluminium production depends entirely on large amounts of cheap hydro-electric power.

Modern cement dates from about 1850; and although its chemistry is still not fully understood, high grades are available in large quantities. A recent advance is the production of low-heat cement. The use of reinforced concrete is widespread, and latterly the technique of pre-stressing has resulted in considerable savings in materials in some cases.

Earthwork has only been scientifically treated since the early 1920's, when Dr. Terzaghi began to publish his penetrating analyses. Some problems still await solution, but we understand their limits and tendencies. Tunnelling is highly mechanized at present and rapid progress is possible. In soft ground, by use of a shield, a 12-ft. Tube railway tunnel in London clay can be advanced by as much as 160 ft. a week.

Prefabrication was used on a large scale for marine works during the War; for example, in the well-known invasion harbours and the lesser-known permanent military ports in some of the Scottish sea lochs.

We have had to develop analysis by experimental methods to a considerable pitch. Electrical resistance strain gauges and photo-elastic methods are useful. In aircraft the piercing of the sonic barrier depends greatly on model and wind-tunnel research. In hydrodynamics, models are most useful for determining hull forms, wave action, silting and erosion in harbours, spillways of dams and similar problems.

ANTHROPOLOGICAL APPROACH IN SOCIAL SCIENCE

IN his presidential address to Section H (Anthropology), Prof. C. Daryll Forde discusses the anthropological approach to the social sciences. The social sciences are often regarded as comprising all scholarly studies contributing to the portrayal of social conditions, including historical or descriptive accounts and those directed towards the solution of

practical social problems. But more strictly considered, science seeks to establish valid generalizations concerning the properties of a range of natural phenomena, and its precision and explanatory value depend on the accuracy with which these properties are determined and the relations between them established. In this sense, social science must be concerned with the investigation of the nature and conditions of social relations, and should seek valid generalizations concerning variation in the social life of the human species. Interpretations of particular societies past or present, and predictions as to particular social developments in the future, depend for their penetration and reliability on achievement in this more strictly scientific field. This dependence of advance in descriptive and practical studies on the development and application of theory is generally recognized in the field of economics, but has been less readily appreciated by students of social history, politics and ethnology.

Anthropology, traditionally concerned with the study of savage or pre-literate peoples, has developed in response to historical and practical, as well as scientific, interests. But interest in the organisation of these small-scale societies has been considerably stimulated by the hope of obtaining therefrom greater insight into problems of our own civilized societies through a better understanding of universal processes in the social life of man. The comparative study of the whole range of social forms is required for the formulating and testing of fundamental hypotheses concerning the nature of society. As in other scientific fields, advance is often easier with reference to less complicated material provided by small-scale 'primitive' societies. Moreover, the novelty and variety of institutions and social relations in such societies direct attention to problems which tend to be obscured by the particular conditions and conventional definitions current in our own society.

Anthropological studies in the field of culture have traditionally included both descriptive or ethnographic and analytical or sociological studies. It is important to recognize that as in other fields of knowledge, developments in each are interdependent. The scientific study of the social organisation of small-scale societies depends on the analysis of ethnographic data. Ethnography in turn has been rendered intrinsically more adequate and coherent by advances in sociological theory which have posed new questions and provoked new methods.

Thus earlier descriptions of societies organised in wide uni-lineal kin groups, of which only formal and ceremonial features were commonly emphasized, left obscure the processes whereby such groups were formed and maintained, and failed to reveal their role in maintaining social coherence and control among peoples where there is little specialization of activity and status. Analysis of rights and status in ritual, economic and political spheres has led to the discovery of a high degree of segmentation at a series of levels within these and other corporate bodies in other small-scale societies, and has revealed opposed tendencies to solidarity and fission within such groups as part of the adaptive character of social structure in relation to ecological conditions.

The study of corporate activity and leadership in small-scale societies shows that processes which in more complex societies are expressed in specialized religious, economic and political institutions are not absent among the former, but operate through less differentiated, multifunctional organisations. The categories of economics, religion, law and government are found to have wider reference and more variable inter-relations than is commonly recognized from the study of Western societies.

From the internal analysis of particular societies, and comparative studies, the range of conditions in which specialized institutions emerge are being more closely determined. Spencer's hypothesis of social evolution greatly stimulated the development of social anthropology in the nineteenth century. The comparative study of institutions in relation to the total social structure on one hand, and the ecological foundations of social life on the other, promises to yield a theory of social development more valid than the unverifiable speculations concerning the social conditions of early man into which interest was temporarily diverted in the nineteenth century.

WIDER APPLICATIONS OF TEACHING OF PHYSIOLOGY

THE main feature of Prof. Winifred Cullis's address to Section I (Physiology) is a plea for the training of more physiologists and a wider use of their services. Physiology, if it is to take its proper place in education, has a dual function to perform. Its importance in the teaching of medical students is well recognized; but there is too little appreciation of its other aspect as a science which, apart from its medical bearing, is important for the general health of the community. A plea for a wider recognition of this aspect was chosen for the address, not only because Prof. Cullis's war-time experience broke her contact with the more academic side of physiology, but also because in her opinion it is one insufficiently recognized and one in which she is able to draw upon personal experience.

The community owes much to physiology and is interested in hearing of this debt. The newer knowledge of nutrition, with which will always be associated the name of Sir Frederick Gowland Hopkins, has shown its use in dealing with the restrictions imposed by war-time conditions. The story of insulin, itself of great interest, has a special value in these days of popular writings, in giving some idea of the time that may elapse between the making of a discovery and its safe and general application. The decision of the men of Smithfield not to increase the price of pancreatic material, after hearing what this material could mean in giving to diabetic patients the chance of an active life, is a dramatic instance of the value of knowledge. Possibly, too, a better knowledge of physiological principles might enable the public to evaluate more correctly some of the fantastic claims made in advertisements of certain preparations.

Well-qualified teachers of physiology would be of use in many directions. They are much needed in the general training colleges as well as in those devoted to the training of teachers of domestic science and of physical training. They would be of great value in schools in the upper forms, where they could build upon the foundations often so well laid in the junior forms by good biology teaching. In these institutions and in industrial establishments they could be of use in collecting the normal physiological data now recognized as necessary in the departments

of social medicine. Social science workers would be helped by such instruction, and in extra-mural university classes and in adult education such teachers could play an important part.

To provide these teachers it will be necessary for the universities to increase the number of students taking honours courses in physiology, but who are not going on to medicine. It will also be necessary for the various educational institutions to realize the value of having on their staffs teachers so trained.

In schools, broadcasting and films can be useful aids, though they in no way lessen the responsibility of the class-room teacher, from whom the main inspiration must always come. In preparing such aids it is necessary to have co-operation between three sets of experts, the class-room teacher and the experts in the subject and in the medium to be used. It is necessary, too, for teachers to have training in the of such use aids.

It is Prof. Cullis's firm conviction that this wider teaching of physiology would result in a better understanding of various problems intimately associated with healthy living, so leading to a higher and better standard of health for the individual.

MAN'S ADAPTABILITY

THE question of the adaptability of man was the theme of Dr. S. J. F. Philpott's address before Section J (Psychology). Many of the problems psychologists have handled during the War and that will face them during the peace have had to do with man's adaptability. Can a bank clerk be changed, almost overnight, into a tank gunner? Can he be changed back by a stroke of the pen?

If the doctrine of round pegs in round holes were strictly true such transformations would be difficult, if not impossible. In practice, they can take place with surprising ease, especially if the will to act is present. There are limits. Broadly speaking, men are only adaptable within the limits of their all-round ability; but granted the will and the ability, man can play many parts.

In asking just how an individual is equipped and just how he can adapt himself, we must realize that he works as a whole. When in the workshop planing or sawing a piece of wood, it is my body as a whole that I use, throwing it now into the attitude appropriate to the use of a plane, now into the attitude appropriate to the use of a hand saw. I do not use a planing organ or a sawing organ.

In similar fashion, I am now in the mental attitude appropriate to making an abstract. In a moment I may be in the frame of mind appropriate to making some calculations, or writing a letter, and so on. It is my mind as a whole that I use in each of these operations. I do not use an abstracting organ or a calculating organ.

The problem of education into a given culture is that of giving the individual an enormous number of such attitudes, skills or techniques, ranging from the simplest of everyday actions like opening doors up to the highest expression of the arts and sciences. We only begin to realize the significance of the complex of skills thus built up when we learn about 'wolf children' realizing how much they have lost. Yet no matter how complex the result of all this training, it still remains that all activities can be traced to the functioning of the one general-purposes body-mind instrument.

The problem of drill arises whether in peace or war. It is that of making these various techniques automatic. One cannot enjoy riding a bicycle until all movements of hands and feet and body take place well below the conscious level. No man can be master of his craft until he has made himself a slave to the minor habits involved, the fingering of his instrument or the handling of his tools.

Before advising training, we often to-day apply tests of potentiality. The naïve view is that we ought to be able to devise tests to distinguish between those born to be tank gunners and those born to be tank drivers. In fact, a one-time carpenter can often succeed at either of the other two occupations. Granted that at the moment he knows nothing about either of them, will tests for potential drivers or potential gunners pick him out? If so, will it not be a case of a test for drivers picking out a potential gunner? Or so far as that goes, will it not have picked out an actual carpenter? Put briefly, although it is easy to devise tests of all-round ability (trainability or adaptability) it is quite another matter to discover tests that shall assess potentiality in respect of some one occupation and it alone. There is wide overlap. The bearing of this on problems of peace, such as that of advising children into the best form of education, is obvious.

THE HISTORY OF PLANT FORM

ALTHOUGH in recent years botanists have been mainly interested in the study of growing plants, many of their generalizations are based on a belief that evolution has taken place in the plant world. But since very little historical evidence of the evolution of the flowering plants has been forthcoming, this belief has become a dogma, maintained in spite of the absence of proof. This unsatisfactory position, said Dr. H. Hamshaw Thomas, in his presidential address to Section K (Botany), warrants a survey of our present knowledge of the fossil record.

Past failure to find any clues to the early history of the flowering plants may be due to a deductive examination of the evidence. The logical basis of evolutionary study is different from that of pure or typological morphology, but it has been assumed that the *Urform* of the pure morphologist represents the primitive type of flowering plant. Consequently we may have been searching for structures which have never existed. The actual record of changes in plant form through the ages suggests the evolution of the angiosperms through types very different from those imagined.

The geological record becomes clearer if we compare the plant forms from successive *terrestrial* periods, dividing the geological time-scale in a manner complementary to the normal classification of strata, the groups of which represent periods of marine sedimentation. Owing to the rare conditions under which plants are preserved as fossils, we can never hope to trace real phylogenies, but we can obtain evidence of the ways in which structures have changed in the past 400 million years.

The remains of the Upper Silurian–Lower Devonian land plants show forms widely different from the plants of to-day. Types with smooth forking axes predominated; they had little differentiation into

stems, roots and leaves. During the Middle Devonian period there were leaves of several types which seem to be derived from specialized photosynthetic branches. A variety of large, much divided fronds appears in the Upper Devonian–Lower Carboniferous rocks; their ultimate segments were usually small or narrow. Several of them belonged to seed-bearing plants—the pteridosperms. In Upper Carboniferous–Lower Permian times this group had more compact fronds, with larger, partly concrescent pinnules; reticulate venation appeared in some genera. Among these, *Gigantopteris* approaches the type of leaf now characteristic of dicotyledons. Petrified stems with a wide range of structure have been found; some of them suggest an approach to angiospermous structure.

The sequence of reproductive structures forms a coherent series which should be studied without reference to morphological preconceptions. Most of the earlier types had their sporangia on the ends of fertile branches, often in groups. This habit continued through Upper Palæozoic times. Kidston described six different forms of pteridospermous pollen-bearing structures from the Lower Carboniferous, with terminal groups of radially arranged sporangia, and Halle has investigated a number of similar structures from the Upper Carboniferous. All are constructed on the same general plan, which is also seen in the male flowers of many unisexual angiosperms to-day. These structures, as well as the cupulate seeds, generally grew on special branch systems. Halle's suggestion is recalled, that in one line of pteridosperm evolution the plant body was differentiated into a vegetative and a reproductive region, the spore-producing members congregating to form some kind of inflorescence or flower borne directly on branches of the stem and not on leaves. The Triassic pteridosperms from South Africa had dichasial inflorescences and support this view. Another link between the pteridosperms and the angiosperms is provided by certain rare and undescribed fossils from the Molteno beds of South Africa. These show inflorescences of a dichasial type, bearing small flowers with delicate perianth segments.

The closed ovary of the angiosperms may have been derived from the open cupules of the pteridosperms. The Jurassic *Caytonia* suggests how the closure may have come about, and Prof. Doyle's researches on pollination and fertilization in the conifers are interesting in this connexion.

Traces of flowering plants occur in the Upper Jurassic and increase in number until they form more than 90 per cent of the floras in the Eocene rocks. The widely different types present in Cretaceous beds suggest that the group must have originated in Upper Palæozoic or early Mesozoic times. An investigation of the spore content of freshwater sediments may throw light on this suggestion. A high percentage of the families represented in the Upper Cretaceous–Lower Tertiary floras show primitive characters in their secondary wood; by statistical analysis, Sporne has been able to discover other characters probably possessed by the more primitive dicotyledons.

All these studies are independent of morphological theory, and since plant morphology has developed as a deductive study they suggest that a reconsideration of its concepts are necessary. The War showed the importance of a complete and objective analysis of information as a basis for action. This is a principle applicable both to the problems which have been here considered, and to all the affairs of national life.

EVOLUTION OF SECONDARY EDUCATION

IN her presidential address to Section L (Education), Miss Lynda Grier discusses "The Evolution of Secondary Education in Britain". The most notable features in the evolution of secondary education in Britain have been, she said, the growth and constant power of the classical tradition, and its decay; the growth of democracy, including the growth of the woman's movement; the coming of science with a new conception of humanism in education, and the interest in technical education.

The dominance of classics in education in the first instance was due to the fact that they were useful and paved the way to office in Church and State, that they were necessary to lawyers and diplomatists, won favour at court, and were, in brief, the main requisite for any who wished to enter the learned professions. Conservatism kept classical teaching powerful when the direct usefulness of the classics had ceased, and brought about a decline in the number of grammar schools, and in the numbers at the universities, until the latter began to take note of the new learning, and it was slowly recognized that education should have some connexion with the world in which men and women had to live. This recognition was due to the growth of democracy and the increasing need of the sciences for the contribution of learned thought and training. As these things came to the fore, secondary education began slowly to take its rightful place in men's minds as something that should be offered to all children.

Early democratic ideas in education in England, unlike those of Commenius, were selective and concerned with the provision of ladders for the poor and able, which would set them side by side with the rich, or even, as some of the most democratic of early English thinkers suggested, above the rich, if the rich were not worthy of the education offered. Hence the English system was profuse in scholarship provision, generously but definitely selective. Interest in the higher education of women suffered an even greater decline than did that for men, until the gradual emergence of a true democracy.

Mathematics and science were not neglected entirely, for indeed much fine work was done in both. But it was carried on outside the universities and grammar schools; and schools of a different type were set up for their teaching, or else, as suggested by Locke, they were taught by private tutors, until at last the ancient universities began to recognize their importance. Technical education, which should long since have come into an important place in education, given the decay of apprenticeship and the competition of other countries, has only recently established its claims in the provision of secondary education.

The general neglect by the State of secondary education in Britain allowed for great variety in it, since what was done was in the hands of private bodies and individuals with widely different points of view. The recent Education Act and all the interpretations given to it by the Ministry of Education recognize the value of that variety. In achieving for the first time a complete system of education, with secondary education for all, it is recognized that unity is incompatible with uniformity, and that the greater the variety the more perfect can be the result.

SOILS AND HEALTH

THE effect of soil conditions on plant and animal health forms the topic of Dr. W. G. Ogg's presidential address to Section M (Agriculture). Great advances have been made in this subject during the past quarter of a century. One of the most interesting discoveries is the part played by what are termed the trace elements from the fact that traces only are normally required. Some of these appear to affect plants only; others both plants and animals; and yet others, animals only. Deficiencies or excesses of these substances have been shown to be responsible for a wide range of plant and animal diseases and cause large annual losses to the agricultural industry. Probably the sub-clinical cases are far more numerous than those with obvious symptoms of disease, and are responsible for even greater losses. We do not know very much about the way in which the trace elements act, but possibly they are catalysts.

Although these trace-element diseases are spectacular and highly important, the major plant foods have a much greater influence on the food supplies and health of the community, and deficiencies of these are much more widespread.

It is obviously of very great importance to agriculture to have as much information as possible about the natural distribution and availability of both major plant foods and trace elements. Much of our knowledge on this subject is due to the geochemical studies of the late V. M. Goldschmidt. He developed improved methods of quantitative spectrography which have been of great value in obtaining the necessary analytical data, and his work on crystal chemistry has thrown much fresh light on the distribution of the trace elements in the earth's crust.

The introduction of fertilizers about a century ago has led to an enormous increase in food production throughout the world. It is not claimed that they have supplanted organic manures. Both have their uses and they should be regarded as complementary. Apart from other considerations, fertilizers are needed if the world's food supply is to be maintained because of the shortage of organic manures.

Violent attacks by some of the enthusiasts for organic manures have been made on the use of fertilizers. It is claimed that they poison the soil and are detrimental to the health of plants, animals and human beings. There is no good evidence in support of these assertions. Far from doing harm, fertilizers, properly used, build up soil fertility. In fact, by enabling larger crops to be grown, they increase the amount of material which can be converted into farmyard manure, and the greater amount of roots and other crop residues also increases the organic matter in the soil. For the same reason they are beneficial rather than detrimental to the soil's population of earthworms and micro-organisms. Nor is there sound evidence in support of the assertion that fertilizers increase the liability of crops to insect, fungus or virus attack, or that they have a detrimental effect on the composition and quality of agricultural produce.

Probably more can be done for the improvement of health in the world to-day by providing ample supplies of food than in any other way, and the propagation of unfounded beliefs about the harmful effects of fertilizers is detrimental to the interests of the whole community.

LOCAL SCIENTIFIC SOCIETIES

AS in many other fields, there is a tendency to take stock, and there has been a suggestion, both expressed and implied, that the day of the local society is past. The Council of the British Association has had the matter under consideration and has circularized its corresponding and affiliated societies asking for detailed information on certain points and for suggestions. The replies have been collated, and the president of the Conference of Delegates of Corresponding Societies, Dr. J. Ramsbottom, made them the basis of his address with the intention of promoting discussion.

Local societies had their origin for the same purposes as the so-called learned societies and even as the old universities—the dissemination or communication of knowledge and the furthering of research. Gresham College, 1596, with its endowed lectures, and the foundation of the Royal Society in 1660, show how in the sixteenth and seventeenth centuries these objects were met. With the advance in learning in the eighteenth century and the realization of the benefit of mutual exchange of ideas, many literary and social clubs met in London coffee-houses and taverns, and larger literary and philosophic societies were founded in different large provincial towns—Edinburgh 1731, Manchester 1781, Newcastle 1793, and so on. Specialized societies began to make their appearance with headquarters in London: the Linnean Society 1788, the Geological Society 1807, Zoological Society 1826 and Entomological Society 1833.

The natural history society may be considered a product of the Victorian era. It was essentially an association of people interested in nature study at a period when systematic botany and zoology were generally regarded as the main part of these subjects. Many of our local Floras and Faunas were due to their activities, and much of real value was published on other branches of biology.

At the present time, most local societies carry on much in the way which was so profitable up to fifty years ago. Since then there has been a crop of societies and clubs dealing with special branches of biology; but the *omnium gatherum* local natural history societies continue, though many cannot be said to flourish. Some, under the stimulus of one or more members, have tended to specialize, but undue specialization defeats its own ends; sections acting as local branches of the larger societies dealing with these subjects would be more profitable. The federation of local societies into regional unions, beginning with the Yorkshire Naturalists' Union, 1877, has proved advantageous and stimulating; but there is need for some collaboration between the unions themselves.

Most natural history societies lament their small membership, particularly the absence of young members. Their enrolment is a task of national importance, for the country will need an increasing number of trained biologists, and it is beyond question that field work is the most profitable method of approaching many fundamental problems as well as inspiring a true interest in biology.

The compilation of records has always been carried on by local societies, and with the possibility of the increase in the number of nature reserves there is opportunity for detailed studies on a broad ecological or biological basis. Indeed, the local natural history societies might play a large part in protecting these areas and in noting others that are worthy of local or national preservation.

NEWS and VIEWS

Physiology at University College, Dundee: Prof. G. H. Bell

Dr. George Howard Bell, who has been appointed to the chair of physiology in University College, Dundee, is a graduate of the University of Glasgow, where he had a distinguished career in both the Faculty of Science and the Faculty of Medicine, gaining the M.B. degree with honours in 1930 and, later, the higher degree of M.D., also with honours. For the thesis which he presented for the latter degree he was awarded a Bellahouston Gold Medal. After graduation, Dr. Bell spent a period in clinical appointments before entering upon an academic career in physiology, and he has always maintained a close interest in clinical problems. He gave a considerable amount of voluntary hospital service during the War. A year ago he was elected a fellow of the Royal Faculty of Physicians and Surgeons of Glasgow. Prof. Bell's career as a physiologist began with his appointment as an assistant in the Glasgow University Institute of Physiology. This assistantship was followed by a lectureship at the University of Bristol, after which he returned to Glasgow as senior lecturer in physiology. His research interests have been concerned in the main with problems in the physiology of parturition and of reproduction in general; with the significance of capillary fragility tests; and, most recently, with the effect of various factors on the physical strength of bone. Many of these studies are notable for, and indeed have depended for their success upon, the development of new techniques and on the design and construction of novel apparatus; and quite apart from strictly physiological research, Dr. Bell has issued many valuable papers on new and improved methods and apparatus, and on the application of nomograms to physiological and clinical calculations. His practical text-book on experimental physiology has gained acceptance not only in Glasgow but also in several other medical schools.

Physical Chemistry at Durham: Prof. W. F. K. Wynne-Jones

Prof. W. F. K. Wynne-Jones, professor of chemistry at University College, Dundee, University of St. Andrews, has been appointed to the chair of physical chemistry at King's College, Newcastle-upon-Tyne, University of Durham, in succession to Prof. H. L. Riley (see *Nature*, Dec. 14, 1946, p. 867). Prof. Wynne-Jones is a D.Sc. of the University of Wales, having begun his academic career at University College, Aberystwyth; later he went to Oxford. He continued his chemical studies with Brönsted at Copenhagen, and spent some time with H. S. Taylor at Princeton University as a Leverhulme scholar. After having held appointments in the Universities of Bristol and Reading, he went, in 1938, to Dundee. During 1942–44, he took over the duties of head of the Chemistry Department of the Royal Aircraft Establishment, Farnborough; and during the War he also supervised electro-chemical research work, which was carried out at University College, Dundee, for the Ministry of Supply. Prof. Wynne-Jones' main research work has been in the field of chemical kinetics. He has worked on acid-base catalytic reactions in solution, and on electrolytic dissociation processes. His work also includes studies in the role of solvent in reaction kinetic processes, and on the effect of isotope exchange on reaction-rates, particularly the exchange of deuterium and hydrogen.

American Awards for British Men of Science

Dr. H. Roxbee Cox, director of the National Gas Turbine Establishment and chairman and managing director of Power Jets (Research and Development), Ltd., has been awarded the American Medal of Honour with Silver Palm for "meritorious service to the Government of the United States from September 1941 to September 1945, in connection with the development of turbo-jet and turbine aircraft engines. Dr. Roxbee Cox contributed to a great extent to the successful prosecution of this major war project by establishing and effectively administering an efficient system of technical collaboration between the British and U.S. Governments."

Dr. E. Talbot Paris, principal director of scientific research (defence) in the Ministry of Supply, has been awarded the American Medal of Freedom with Bronze Palm for "meritorious service during the period of action in the field of scientific research development. As a physicist in the Ministry of Supply, he was responsible for the development of radar communications and other electronic equipment required for the ground forces of the British Army. He took an active part in establishing the interchange of scientific information with American laboratories, contributing substantially to the development of highly technical equipment."

Exhibition at the National Gallery

On October 8 the National Gallery is re-opening a suite of six rooms, the first to be completely redecorated since the War. Many of the pictures to be shown in these have been re-framed. Nearly all will be shown without glass; though they will be protected by low barriers of silk cord. Fluorescent lighting is being installed in all the rooms. In one of them the walls will be covered with loose hangings of damask. These are all experiments towards the method of exhibition to be adopted in another suite of rooms, now half derelict, which is to be completely remodelled and air-conditioned. The pictures hung in five of the redecorated rooms will be the seventy which have been cleaned during the last ten years. In order of cleaning, they will begin and end with the two portraits of King Philip IV by Velázquez. In date they will range from the fourteenth to nineteenth centuries. The exhibition will show the cleaned pictures together for the first time, on clean backgrounds. Examined under these conditions, and with the help of a few demonstration pictures, 120 comparative photographs, X-radiographs, etc., and a catalogue giving the relevant facts, it will be possible to assess the correspondence on the subject which has appeared in the Press during recent months.

South African Science

The first issue of the newly established monthly journal, *South African Science* (*Suid-Afrikaanse Wetenskap*), has just been published (Vol. 1, No. 1, August 1947). This is the bulletin of the South African Association for the Advancement of Science and is available free to members, but may be obtained also by non-members (15*s*. a year, including postage, Kelvin House, H/v Marshall and Hollard-straat, Johannesburg). The journal is similar to *Nature* in format and make up. There are two valuable main articles: "Scientific Research in South Africa", by Dr. B. F. J. Schonland, president of the South African Council of Scientific and Industrial Research, and "The World View of the Physicist", by Prof.

H. H. Paine. Letters to the Editor and Notes and News are given reasonable space, and there is a further article, "The Control of Reverberation in Theatres and Concert Halls", by Prof. P. R. Kirby. An account of the Oudtshoorn meeting of the South African Association completes the number. The editor of *South African Science* is Dr. H. B. S. Cooke, of the Department of Geology, University of the Witwatersrand, who is to be congratulated on the first number of a journal which is clearly needed in such a rapidly developing area as South Africa.

The Indian Archives

The Indian Archives, the first number of which, dated January 1947, has just been received, is a welcome addition to periodical literature on documentation and to the specialist journals of India; its high quality is assured by the fact that it is published by the Imperial Record Department at New Delhi on behalf of the Indian Historical Records Commission. Since the establishment of the Imperial Record Department in 1891 and the Records Commission some thirty years later, much has been achieved, as reference to their many publications will show, in the collection and systematic classification, calendaring and indexing of the Government of India's extant records and in the technical work of their proper care and preservation. But much remains to be done. There are still many districts in India with an untold wealth of valuable archives in charge of unqualified keepers, and some Provinces and States without central record offices. India is not the only country that has in the past been indifferent to the value of its historical records. There, as elsewhere, healthy signs exist of an awakening of the public conscience, and the new journal is intended not only to stimulate this but also to serve as a clearing house for scientific knowledge on matters of archival interest and as an advice and information centre for Indian archivists. The editorial board proposes to print important articles on archival subjects from the foreign press as well as original contributions and papers dealing with India's special problems. This first number has a very interesting selection; it is well produced and will be well received by all concerned with archives and their keeping. It is to appear quarterly.

A New Mycological Periodical

THE well-known periodical *Annales Mycologici*, beginning in 1903, ended with its forty-second volume. The premises of the publisher were destroyed in an air attack in April 1945, and H. Sydow, the editor and founder of the journal, died in the following year. Dr. F. Petrak, the eminent mycologist of the Vienna Museum, has decided to re-start the journal with the title *Sydowia*. It will retain its international character and will appear twice a year, each number containing 12–15 sheets. The first number is to be published this year and will include some papers by Petrak which were contained in Nos. 3–6 of Vol. 42 of the *Annales*, the whole edition of which was destroyed. Mycologists are invited to send original articles for publication in English, French, German, Italian, Latin or Spanish. The price of each volume will be 40 Swiss francs. The publisher is Ferdinand Berger, Horn, Nied.-Österreich; the editor, Dr. F. Petrak, Botanische Abteilung des Naturhistorischen Museums, Vienna, Austria. British mycologists will wish Dr. Petrak success in his venture.

Chymia

THE great interest shown in the United States in the history of science is to find a further expression in the inauguration towards the end of this year of an annual publication on historical chemistry, entitled *Chymia*. It is anticipated that each volume will contain about a dozen articles of some four to five thousand words each, written in various languages and contributed by leading authorities from all over the world. It is appropriate that *Chymia* should be sponsored by the Edgar Fahs Smith Memorial Collection at the University of Pennsylvania, for it was in this University that the first American chair of chemistry was established in 1769, in the Colonial period, and filled by Benjamin Rush, one of Joseph Black's earliest pupils at Edinburgh. The editor-in-chief of *Chymia* is Prof. Tenney L. Davis, with a board of five other American editors and a group of consulting editors of international repute, representing, to date, the United States, Great Britain, France, Switzerland, Sweden, Holland, Germany, the Argentine, Brazil and China. The British contributors to the first volume are Prof. J. R. Partington, Prof. John Read and Dr. F. Sherwood Taylor. The secretary of the editorial board is Miss Eva V. Armstrong, curator of the Edgar Fahs Smith Collection, University of Pennsylvania, Philadelphia. Publication in Britain will be undertaken by the Oxford University Press.

Summer School in Physical Chemistry at Cambridge

DESIGNED to bring industrial research into closer contact with academical research, an eight-day course of lectures and class work was opened in the Department of Physical Chemistry at Cambridge on August 16. The pressure of applications induced the organisers to accommodate 180 rather than the 100 applicants originally contemplated. An unexpectedly high number of representatives came from university colleges, technical colleges and schools. Many officers attended from the research departments of the Ministry of Supply, and some from the Services. The majority were drawn from industrial organisations, headed in by a group of twenty-six from various sections of Imperial Chemical Industries, Ltd. Prof. Norrish's inaugural lecture on the history of chemistry at Cambridge was followed by eighteen lectures given by him and his staff and devoted in equal numbers to molecular structure, its quantal interpretation, its optical investigation and its bearing on pure liquids and solutions; polymerization, oxidations, explosions, photochemical reactions and nuclear chain processes; the mechanism of friction, wear and lubrication, and the induction of chemical change by impact. The course was characterized by a friendly exchange of difficulties between those attending the school and those responsible for it, and by the variety of new experimental techniques available for trial. The final meeting was attended by the Vice-Chancellor and addressed by Mr. A. V. Alexander, Minister of Defence.

Libraries and their Use

SOME of the papers read at the week-end conference of the London and Home Counties Branch of the Library Association held at Eastbourne in October 1946, which have now been issued as a separate reprint (Library Association, 68 Holloway Road, London, N.7. 5*s*.), although addressed

primarily to the public librarian, are of interest to those in charge of scientific or technical libraries and to those using such libraries for research or for other purposes. This applies particularly to the papers in the symposium on special materials in libraries, to which Dr. E. C. Willatts, of the Ministry of Town and Country Planning, contributes some notes on the cataloguing, classification and handling generally of maps, plans and aerial photographs, and Miss D. Tayler, formerly of the Ministry of Information, on the like treatment of pictorial material. Mrs. L. Moholy surveys the various processes of documentary reproduction, including the photostat process and micro-copying techniques, and urges once more the establishment of central offices of documentary reproduction; while two papers by Miss Marie T. Slocombe and Miss Valentine Britten, both of the British Broadcasting Corporation, dealing with sound recordings and describing the B.B.C.'s Recorded Programmes Library and the formation and administration of a gramophone library, respectively, should interest a more limited number of scientific workers. An excellent paper on "Library Co-operation and Publicity", by C. A. Elliott, of the Bermondsey Public Libraries, makes many sound points which could well be laid to heart by the works librarian or the librarian serving a research organisation in industry or elsewhere. The two-fold responsibility is the same: to provide an adequate service and to make it accessible. As in the public library, there is the task of organising an efficient service to meet known needs, of removing all unnecessary hindrances and barriers between the reader and the source of information, and of making known, continuously and effectively, the existence of the service so that it is fully used.

Beilby Memorial Awards

From the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals to be determined by the administrators, representing the Royal Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished work. Preference is given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy, and awards are made, not on the result of any competition, but in recognition of continuous work of exceptional merit, bearing evidence of distinct advancement in science and practice. In general, awards are not applicable to workers of established repute, but are granted as an encouragement to younger men who have done original independent work of exceptional merit over a period of years. The administrators of the Fund will therefore be glad to have their attention directed to outstanding work of the nature indicated not later than November 1. All communications should be addressed to the Convenor, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Information on Solar Activity by Radio

As the central station for international co-operation on solar activity, the Swiss Federal Observatory at Zurich is now giving monthly the daily sunspot (relative) numbers by the short-wave service of the Swiss Broadcasting Corporation according to the following programme:

On the 4th of each month:

	G.M.T.					
(1)	07h.20m.	wave-length	25·39	25·28		for Australia
(2)	15 05		19·60	16·87		„ the Far East
(3)	21 50		19·59			„ South America
(4)	22 30		25·28			„ North America
(5)	23 40		31·46	25·28	19·59	„ South America

On the 5th of each month:

	G.M.T.					
(6)	01h.40m.	wave-length	31·46	25·28	19·59	for North America
(7)	03 05		31·46	25·28	19·59	„ North America

For this year, in October, emission 2 will be on October 3 instead of October 4. Emissions 3 and 5 are in Spanish, the others in English.

The Night Sky in September

New moon occurs on Sept. 14d. 19h. 28m., U.T., and full moon on Sept. 30d. 06h. 41m. The following conjunctions with the moon take place: Sept. 10d. 11h., Mars 3° N.; Sept. 12d. 10h., Saturn 4° S.; Sept. 19d. 10h., Jupiter 0·6° N. Mercury and Venus are badly placed for observation during the month and Venus is in superior conjunction on Sept. 3. Mars, in the constellation of Gemini, is visible in the morning hours, rising a little before 0h. during the greater portion of the month. Jupiter, in the constellation of Libra, can be observed in the early part of the night, setting at 21h., 20h., and 19h. 20m. at the beginning, middle, and end of the month, respectively. Its stellar magnitude varies between − 1·6 and − 1·4 during September. Saturn can be seen in the constellation of Leo in the morning hours, rising at 3h. 05m., 2h. 20m., and 1h. 34m., at the beginning, middle, and end of the month, respectively, and is easily recognized by its yellowish hue. Only one occultation of stars brighter than magnitude 6 takes place: Sept. 28d. 01h. 42·5m., τ Aquar.(*D*), the latitude of Greenwich being assumed and *D* referring to disappearance. The autumnal equinox occurs on Sept. 23d. 21h.

Announcements

The Committee of Privy Council for Medical Research has appointed Prof. N. Hamilton Fairley, professor of tropical medicine in the University of London, and Prof. J. H. Gaddum, professor of materia medica in the University of Edinburgh, to be members of the Medical Research Council as from October 1.

The Paint Research Association will celebrate its twenty-first anniversary on Tuesday, September 23 and following days, and the Paint Research Station, Teddington, will be open to visitors. On September 25 Sir Thomas Merton will give a short address, followed by a lecture by Dr. D. A. Sutton entitled "Is Copal Varnish an Alkyd?"; on the next day Sir Lawrence Bragg will speak, and will be followed by a lecture by Dr. G. Herdan entitled "Paint and Mathematics". Applications to visit the Station should be sent to the Director, Paint Research Station, Waldegrave Road, Teddington, Middlesex.

The twenty-second annual conference of the Association of Special Libraries and Information Bureaux will be held at the London School of Economics during September 20–21. The topics to be discussed include the effect of atomic energy developments on scientific and technical publication (Prof. R. E. Peierls); punched card systems in library work (Dr. J. W. Perry, Dr. W. E. Batten and Dr. G. M. Dyson); and format of periodicals (Dr. V. E. Parke, L. J. F. Brimble and L. G. Patrick). Particulars of the meeting can be obtained from the Secretary of the Association, 52 Bloomsbury Street, London, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of Testicular Hormone on the Formation of Seminal Fructose

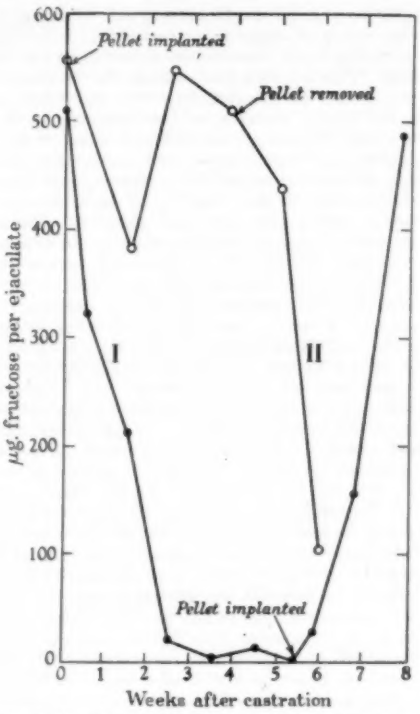
PREVIOUS experiments have established the fact that mammalian semen contains fructose, its concentration varying from a few mgm. per cent in boar to 1,000 mgm. per cent in bull; this sugar serves the spermatozoa as their natural nutrient, and they readily metabolize it[1,2]. At the site of its origin in the testis, and in the epididymis, the semen contains very little fructose but acquires it during its passage through the male generative tract, from the accessory glands of reproduction, mainly the seminal vesicles[3].

In the course of experiments designed to solve the mechanism of fructose formation in the accessory glands, we have now found that the process of fructose generation is linked in a striking manner with the action of the testicular hormone and, furthermore, that characteristic fluctuations in the level of seminal fructose can be evoked in response to testosterone. For the investigation we have used sixteen fully fertile bucks; some of them were castrated, while the others were used as controls. The collection of semen was carried out at weekly intervals by the method of Macirone and Walton[4]. Fructose was determined by the method previously described, using 0·1 ml. samples of semen and 0·05–0·2 gm. samples of the various tissues[3].

EFFECT OF TESTOSTERONE ON FRUCTOSE CONTENT IN ACCESSORY GLANDS

	Gl. vesicularis and seminalis		Prostate	
	Weight mgm.	Fructose mgm. %	Weight mgm.	Fructose mgm. %
Non-castrated buck	780	62	860	79
1 week after castration	860	84	590	18
2 weeks after castration	630	5	410	5
5 weeks after castration	420	3	540	3
8 weeks after castration and simultaneous implantation of testosterone pellet (100 mgm.)	1100	29	1170	71

Within the first two or three weeks following castration, there was a remarkable fall in the fructose content of accessory glands, and usually by the end of the second week the organs were almost completely depleted of fructose. This post-castrate fall in fructose, however, could be prevented by the implantation of pellets of pure testosterone under the skin of the castrated animals (see table). An even clearer picture was obtained through the study of the effect of testosterone on the level of fructose in the semen itself, as illustrated in the accompanying graph. Castration caused a sharp decrease in both the volume of ejaculates as well as in the concentration of fructose in semen, so that the actual quantity of fructose per ejaculate, which normally amounts to some 500 μgm., dropped within three weeks following castration to less than 20 μgm., remaining low until a pellet of testosterone was implanted. In response to testosterone, there was an increase in the volume of ejaculates together with a rise in fructose which soon reached the pre-castration level (Curve 1). In presence of the pellet, a high concentration of fructose could be maintained in the castrated animal for several weeks. However, when the pellet was removed, a significant fall in seminal fructose was registered again (Curve II). From these results we are inclined



to conclude that testosterone is the hormone responsible for the formation and maintenance of fructose in semen.

It has long been known that the weight, size, histological appearance and secretory function of certain accessory organs, notably the seminal vesicles and prostate, are strictly dependent on, and closely regulated by, the internal secretion of the testes; and that the typical retrogressive changes which develop in the accessory glands after removal of the testes can be counteracted by injections of the testicular hormone, thus serving as 'indicator tests' for the male hormone. To these biological tests may now be added the highly sensitive 'fructose test' whereby the testicular hormone can be conveniently assayed in castrated animals, simply by examining the fructose content of the semen or of the accessory glands. It may be added that the post-castration fall in the level of fructose and its restoration by testosterone occurs more rapidly and is much more marked than the rather slow and gradually developing gross morphological changes in the accessory glands of reproduction.

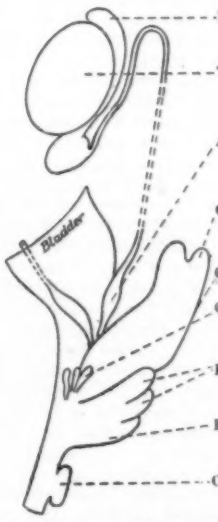
This work has been carried out on behalf of the Agricultural Research Council. We are grateful to Dr. J. Hammond, Mr. J. Hammond, jun., Prof. D. Keilin and Dr. A. Walton for placing the experimental animals at our disposal, for help and advice, and to Dr. W. J. Tindall, Organon Laboratories, for a gift of pure testosterone.

T. MANN
URSULA PARSONS
Molteno Institute and School of Agriculture,
University of Cambridge. June 7.

[1] Mann, T., *Nature*, **157**, 79 (1946.)
[2] Mann, T., *Biochem. J.*, **40**, xxix (1946).
[3] Mann, T., *Biochem. J.*, **40**, 481 (1946).
[4] Macirone, C., and Walton, A., *J. Agric. Sci.*, **28**, 122 (1938).

Functional Development of Accessory Glands and Spermatogenesis

WHEN fructose was established as the normal nutrient material for spermatozoa and its origin traced to the seminal vesicles[1], it remained to be explained how certain animals, such as the rabbit, secrete fructose in semen in spite of the absence of seminal vesicles. The rabbit, however, has a large complex organ, sometimes referred to as the 'prostate', which has been described hitherto as composed of three glands, 'gl. seminalis', 'gl. vesicularis' and 'prostate proper', each with an independent urethral outlet[2]. However, our recent investigation of the development of the male reproductive system in the rabbit has established that the gl. seminalis develops in conjunction with the gl. vesicularis from the same diverticulum of the Wolffian duct; further, both glands possess a common urethral outlet, and gl. vesicularis as a whole, rather than the gl. seminalis by itself, should be regarded as homologous to the seminal vesicle in other mammals[3]. This, incidentally, explains the presence of fructose in the gl. vesicularis. It should be pointed out, however, that in the rabbit, apart from this gland, fructose also occurs in the ampulla of the vas deferens as well as in the 'prostate proper'. The distribution of fructose in the various parts of the reproductive system of the male rabbit is shown in the accompanying sketch.



	Weight of organ (mgm.)	Fructose in organ (mgm.)	Fructose (mgm./100 gm. tissue)
Epididymis	600	0·03	5
Testis	2900	0·06	2
Ampulla	130	0·03	23
Gl. seminalis	150	0·04	26
Gl. vesicularis	920	0·79	85
Gl. paraprostatic æ	190	0·092	48
Prostate I and II	335	0·368	110
Prostate III	475	0·272	57
Cowper's gland	1000	0·0	0·0

In the course of investigations on the development of the reproductive system in the rabbit, we noticed that fructose appeared in the accessory glands at an early stage when there was as yet no sign of active spermatogenesis. In a four-months-old animal, both the gl. vesicularis and the prostate showed already a fairly high concentration of fructose (21 and 44 mgm. per cent, respectively) in spite of the complete absence of spermatozoa in the testis or the epididymis. When, in the sixth month of life, the spermatozoa finally made their appearance, the accessory glands were filled with secretory fluid containing the normal high level of fructose. Experiments on bull-calves gave similar results, showing that the appearance of fructose in the secretory fluids of the accessory glands precedes the onset of active spermatogenesis.

Thus it appears that the male reproductive organs first accumulate a store of nutrient material, so that when the motile spermatozoa make their appearance in the generative tract, the fructose reserve is available, ready to be utilized. Together with the recent finding that the formation of seminal fructose requires the presence of the testicular hormone[4], our experiments provide additional evidence that the testicular hormone begins to function in the body some time before actual spermatogenesis.

D. V. DAVIES
T. MANN

School of Anatomy, and Molteno Institute,
University of Cambridge. June 7.

[1] Mann, T., *Biochem. J.*, **40**, 481 (1946).
[2] Leydolph, W., *Z. mikr.-anat. Forsch.*, **19**, 285 (1930).
[3] Davies, D. V., and Mann, T., *Proc. Anat. Soc.*, April 25, 1947.
[4] Mann, T., and Parsons, U., see preceding communication.

Oxidation of Insulin by Performic Acid

FROM the determination of the terminal residues of insulin, it was suggested that the submolecule of molecular weight 12,000 is made up of four peptide chains bound together by —S—S— linkages[1]. Thus if one could break the —S—S— linkages without affecting any other part of the molecule, it should be possible to split the insulin into its separate polypeptide chains, two of which have terminal glycyl residues and the other two phenylalanyl residues. Toennies and Homiller[2] showed that the only amino-acids that are appreciably oxidized by performic acid are tryptophan, methionine and cystine, the latter reacting with five atoms of oxygen and presumably forming cysteic acid. Since insulin contains no tryptophan or methionine, this seemed a suitable way of splitting the —S—S— linkages.

Using the procedure of Toennies and Homiller, it was found that the oxidation of cystine to cysteic acid is complete in five minutes. With insulin an oxidation-time of 15 minutes was generally used. The oxygen consumption was the theoretical one for the cystine content, and paper chromatography[3] showed no qualitative difference in the amino-acid composition except the replacement of cystine by cysteic acid. There was no destruction of the free amino-groups[1]. The oxidation product was studied in the electrophoresis apparatus of Tiselius. Unfortunately, it was not possible to dialyse the material, due to its low molecular weight (about 3,000), so that the results were not always entirely reproducible. Fig. 1 illustrates a typical experiment, which shows three components and indicates that the mixture is not unduly complex.

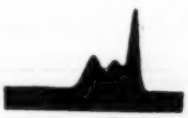


Fig. 1. ELECTROPHORETIC DIAGRAM OF OXIDIZED INSULIN

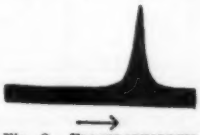


Fig. 2. ELECTROPHORETIC DIAGRAM OF FRACTION *A*

By neutralization at *p*H 6, two fractions of about equal weight can be obtained. The solution (fraction *A*) contains predominantly (80 per cent) glycyl terminal residues, and the precipitate (fraction *B*) predominantly phenylalanyl terminal residues. By further treatment of fraction *A* a product can be obtained which has no phenylalanyl terminal residues and appears to be homogeneous by electrophoresis (Fig. 2). It contains no lysine or arginine. Estimation of the terminal glycyl residues suggested a molecular weight of about 2,500. Fraction *B* has not yet been further purified.

The work is being continued, and a more detailed report will be published later.

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Malonate and Plant Respiration

SINCE Quastel and Whetham's discovery in 1925 [1], biochemists have come to regard the malonate ion as one of the very few specific enzyme inhibitors—as a competitive inhibitor of succinic dehydrogenase[2]. Malonate has therefore been widely used with animal tissue, in work designed to elucidate the Krebs cycle. Recently it has also been applied to plant tissues, but with discordant results. Machlis[3] showed that malonate inhibited part of the respiration of barley roots; but several other workers have independently stated that malonate does not inhibit and may even stimulate plant respiration[4–7].

In 1938, Turner[8] pointed out that the apparent differential effect of iodoacetate on respiration and fermentation was probably explicable in terms of the different rates of penetration of the drug into the cells, under aerobic and anaerobic conditions. In spite of a general increase in our knowledge of cell permeability, this aspect of work with inhibitors and living tissue is still neglected. It is highly probable that the reported lack of inhibition of plant respiration by malonate is due simply to the use of the malonate ion instead of the malonic acid molecule as a cell penetrant.

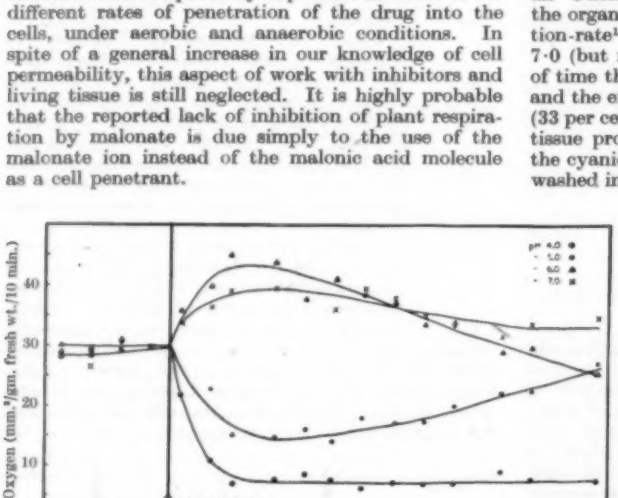

FIG. 1. REACTIONS OF TISSUE RESPIRATION TOWARDS POTASSIUM MALONATE SOLUTIONS OF INCREASING ALKALINITY. UNDISSOCIATED ACID IN SOLUTION: *p*H 4, 98%; *p*H 5, 84%; *p*H 6, 33%; *p*H 7, 5%. CARROT TISSUE, 308 HOURS FROM CUTTING

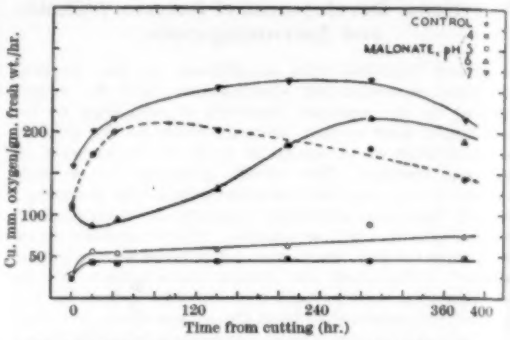

FIG. 2. DRIFT OF RESPIRATORY RESPONSES OF CARROT TISSUE TOWARDS POTASSIUM MALONATE SOLUTIONS, WITH TIME FROM CUTTING. THE VALUES PLOTTED ARE THE MINIMUM (OR MAXIMUM) RATES OF OXYGEN UPTAKE ACHIEVED IN THE SEVERAL EXPERIMENTS

In work with tissue slices of carrot root we have found (Figs. 1 and 2) that potassium malonate (0·05 *M* in distilled water) at *p*H 4·0 causes inhibition of that fraction of the respiration which is inhibited by cyanide[9]. The malonate effect at *p*H 4·0 therefore supports the view of Marsh and Goddard[10] that the cyanide-sensitive respiration in carrot is mediated by the cytochrome-oxidase system, for this is coupled with succinic dehydrogenase.

At *p*H 4, about 98 per cent of undissociated malonic acid is present and might be expected to penetrate cell membranes rapidly. As shown in Fig. 1, very different results are obtained if malonate is applied at *p*H 5, 6 or 7, rather than at *p*H 4. At *p*H 7·0, when only 3 per cent of the undissociated acid is present, the potassium malonate causes a clear stimulation of the oxygen uptake. Because of the associated *R.Q.* effects, we provisionally assign this stimulation to the effect of the potassium ion in bringing about an 'Ulrich' effect, that is, a shift in the balance of the organic acids which leads to an increased respiration-rate[11]. Malonate effects at *p*H between 5·0 and 7·0 (but not at 4·0) vary markedly with the period of time that elapses between the cutting of the slices and the experiment (Fig. 2). For example, at *p*H 6·0 (33 per cent molecule) malonate applied to freshly cut tissue produces a clear-cut but partial inhibition of the cyanide-sensitive respiration. If the tissue is first washed in distilled water for 300 hours, the malonate causes stimulation of the respiration; if the tissue is washed for only about 200 hours, the malonate has no effect whatever upon the rate of oxygen uptake. These curious effects are difficult to explain at present; but at least they emphasize once again the fact that freshly cut tissue slices differ remarkably from long-washed, 'aged' slices in their physiological behaviour[12].

Where the authors who have noted no inhibition of plant respiration by malonate have stated fully their experimental technique, it is usually possible to explain their results in terms of the facts recorded above. Malonic acid appears to enter the cell membrane at an appreciable rate only as the undissociated molecule. As the actual enzyme inhibitor is probably the malonate ion, it is to be presumed that the

succinic dehydrogenase of plant cells is not located on the outer cell membrane as was suggested for bacteria by Quastel.

We have extended this work to red-beet tissue, which was stated by Bennet Clark and Bexon[4] to be insensitive to malonate. We find that the effects of malonate on beet-tissue slices are closely similar to those recorded in Figs. 1 and 2 for carrot. There is one interesting difference. Malonic acid at *p*H 4·0 causes inhibition of the cyanide-sensitive respiration[13] of beet tissue, but (for well-washed tissue only) the rate of oxygen uptake later rises again to a value above the normal rate, after which there is once more a sharp decline. Simultaneously, the cells lose and oxidize some of their vacuolar pigment. We explain this additional complexity as due to the loss of cell organisation leading to non-respiratory oxidation of cell contents.

Although *p*H changes *per se* have some effects on respiration-rates, they can be shown not to be responsible for the malonate effects described. For example, succinic acid produces its greatest stimulatory effects at *p*H 4·0. The increased respiration brought about by this and other organic acids is inhibited by malonate at the same *p*H (4·0), both in carrot and beet tissue. However, results in this laboratory make it doubtful whether malonate acts, *in vivo*, only as an inhibitor of succinic dehydrogenase. Our experiments to date indicate that its inhibitory effect is not reversed by high succinic concentration, or even by fumaric acid.

We are indebted to Dr. R. N. Robertson, with whom we have discussed this problem. This work will be published in full elsewhere.

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Raphanin, an Antibacterial Principle of the Radish (*Raphanus sativus*)

In the course of investigation of the watery extracts of different plants by the cylinder plate method on plates seeded with *Staphylococcus* and *Bact. coli*, it was found that the extracts of the seeds of radish (*Raphanus sativus*) gave a very marked zone of inhibition in both cases, whereas the extract of the root and the leaves did not affect the growth of the bacteria. The antibacterial principle of the extract was resistant to heat, and it could even be boiled on a water-bath for 30 minutes without a marked loss of activity. The substance responsible for the activity was isolated from the water extract of the seeds, and a syrupy liquid was obtained of boiling point 135° C. under 0·06 mm. mercury pressure, which could be distilled as a homogeneous substance. The almost colourless, or slightly yellow, distillate proved to be the active antibacterial principle, and has been termed 'raphanin' by us. As it was estimated on the basis of antibacterial tests, 1 kgm. of the seeds contains about 6–8 gm. of this active principle, the yield of the raphanin on isolation being about 3 gm. per kgm. of seeds.

The raphanin is freely soluble in water, ethanol, butanol, butyl acetate, amyl acetate and chloroform. It is moderately soluble in ether, and very slightly soluble in petroleum ether. The products from different batches proved to be identical, and on elementary analysis raphanin was found to have the following percentage composition: C 41·44, H 5·33, N 8·65, S 33·64. Calculated percentage composition for $C_{17}H_{26}N_2O_2S_5$: C 42·48, H 5·45, N 8·74, S 33·35; and for $C_{17}H_{26}N_2O_4S_5$: C 41·11, H 5·28, N 8·58, S 33·03.

The raphanin is neutral and optically active: $[\alpha]_D^{20°}$ in ethanol being − 141°. The solution of the active principle does not give the recognized test as recommended by Jacobs and Hoffman[1] for unsaturated lactones. When the watery solution of raphanin was heated with the salts of heavy metals, for example, silver nitrate, a great bulk of metal sulphide was precipitated, and the antibacterial action was lost. The antibiotic was not inactivated by cystein. The raphanin is stable between *p*H 3 and 8, but above this is readily decomposed. On shaking with 0·1 *N* baryta at room temperature and neutralizing the excess alkali with sulphuric acid, an inactive crystalline substance was obtained on standing the solution in an ice-chest. This inactive substance, sparingly soluble in water and in organic solvents, was recrystallized in ethanol and the recrystallization repeated in water; m.p. 192–193° C. (uncorr.) at decomposition. The inactive substance contains: C 34·65 per cent, H 5·30 per cent, N 6·73 per cent, and S 45·37 per cent. Formula $C_6H_{11}ONS_2$ requires: C 34·45, H 5·30, N 6·69, S 45·95 in per cents.

When tested by the cylinder plate method on plates seeded with different Gram-positive and Gram-negative bacteria, a solution containing 1 mgm. of raphanin per ml. gave a zone of inhibition in mm. as follows: *Staphylococcus aureus*, 18; *Bact. coli*, 16; *Sal. typhi-H*, 19; *Sal. typhi-O*, 24; *Sal. schottmülleri*, 22; *Bact. Shiga-Kruse*, 16; *Pseudomonas aeruginosa*, 19; *Bact. anthracis* (avirulent), 23; *Bact. anthracis* (virulent), 22; *Bact. subtilis* (strain 'Duthie'), 20; *Bact. prodigiosus*, 12.

Raphanin is highly active in preventing the germination of the seeds of different plants. This kind of effect, which was called by Köckemann[2] the blastokolin effect, is shared by different lactones, particularly by coumarine[3]. A 1 : 1,000 solution of the raphanin prevented germination of the seeds of *Festuca pratensis*, *Brassica oleracea*, *Sinapis alba*, *Cucumis sativus*, *Hordeum distichon*, etc. At a concentration of 1 : 10,000 germination was retarded, and the length of the root was markedly reduced by the end of the third day. Raphanin did not, however, significantly influence the germination of the seeds of radish even at a concentration of 1 in 1,000.

The substance proved to be moderately toxic; 10 mgm. doses given intravenously killed mice, whereas after doses of 5 mgm. mice appeared markedly unwell but recovered within a short time. The perfusion of the isolated frog's heart with raphanin at a concentration of 1 in 800 caused slowing of the heart,

relaxation of the tone and amplitude. This effect showed itself within five minutes and progressed until the heart stopped. After perfusing with Ringer's solution there was recovery of the amplitude, but the pulse-rate remained depressed. A concentration of 1 : 8,000 of the substance did not affect the contraction of the heart.

The growth of tissue cultures from rabbit testicle[4] was hindered by raphanin even at a considerable dilution. A concentration of 1 : 20,000 of the antibiotic prevented entirely the growth of the explants, and a dilution of 1 : 40,000 caused diminished growth of the fibroblasts, as compared to that of the controls.

We are indebted to Prof. V. Bruckner and Dr. J. Kovács for carrying out the elementary analyses.

Full details of these observations will be published elsewhere.

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Thiamine of Milled Raw and Parboiled Rice

It has long been known that the vitamins of cereals are not evenly distributed throughout the grain but are concentrated mainly in the outer coats and in the germ, which consists of the embryo and attached scutellum.

Analyses of the meals and flours of the miller have been somewhat misleading because some mixing of the products from different parts of the grain takes place within the mills. Dr. J. J. C. Hinton, of the Cereals Research Station at St. Albans, dissected cereal grains, accurately separating the different structures, and determined the vitamin content of each structure. He reported[1] that there was a surprising concentration of thiamine in the scutellum of wheat, and that although it forms on an average only 1·54 per cent of the grain, yet it contains 59 per cent of all the thiamine present in the grain. In a later paper[2] he recorded that the scutellum of rye, maize and barley had similar very high contents of thiamine.

This is an important matter in respect of rice milling, for it is probable that rice is not an exception and that much of the thiamine is concentrated in the scutellum. Rice is either milled raw or it is milled after parboiling. Many analyses have shown that parboiled rice is richer in thiamine than highly milled raw rice, and this agrees with the experience that beriberi is very rare or does not occur where parboiled rice is the staple article of diet.

It has generally been accepted that parboiling distributes the vitamins of the pericarp and germ throughout the whole grain, and therefore milling can remove only a small amount with the bran. Recently, I have examined a large number of grains from several samples of raw milled rice and parboiled rice. The great majority of the grains of raw rice had a concavity marking the site from which the whole germ (scutellum and embryo) had been detached. On the other hand, the grains of parboiled rice did not show the concavity; but the site of the germ was flattened as though only part of the germ had been removed by milling. It appeared as though parboiling had made the scutellum more adherent, so that it had not been detached during milling.

Hinton[2] found that twelve hours soaking of wheat did not cause any movement of the water-soluble thiamine to the rest of the grain. He suggested that the cells of the scutellum are not permeable to water until they have been acted upon by acid chloroform or some other agent. Possibly also the high fat content of scutellum may be a bar to the penetration of water.

Parboiling and also the new conversion process, which is parboiling first under vacuum and then under pressure, toughens the rice so that far fewer grains are broken during milling than in the case of raw rice; this lowering of brittleness would help the retention of the scutellum. Probably parboiling does cause some movement of the vitamins within the grain; but its chief value may be the retention of the scutellum.

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Marking Mosquitoes with Fluorescent Compounds and Watching them by Ultra-Violet Light

A technique for marking mosquitoes with fluorescent compounds and watching them by ultra-violet light has been developed, to study the movements of these insects at night without affecting their normal behaviour. The method seems very promising and opens out possibilities for the study of the ecology and bionomics of mosquitoes hitherto not possible.

Zukel[1] used fluorescent compounds to detect marked insects in a large number of specimens, but no attempt was made to develop the technique to observe the insects at night under natural conditions. For this purpose investigations were carried out to ascertain: (*a*) the sensitivity of mosquitoes to shorter wave-lengths, (*b*) whether the insects can take up sufficient dust on their bodies to fluoresce brightly, (*c*) the toxicity of fluorescent compounds to insects, (*d*) whether it would be possible to watch the dusted insects at night by ultra-violet light, and what would be the normal range of visibility.

Mosquitoes, unlike some other insects (honey bees and *Drosophila*), are not sensitive to the ultra-violet radiations of wave-lengths given out by the lamp used (4070–3130 A., 95·5 per cent being concentrated at 3650 A.). Both positive and negative reactions were compared to the behaviour in ordinary light. The species studied were *Anopheles maculipennis* var. *atroparvus*, *Culex molestus* and *Aëdes ægypti*.

Mosquitoes take up sufficient dust to fluoresce brightly, and the dust does not shake off for a number of days. The fluorescent compounds have apparently no toxic effect on these insects as judged by their survival for more than one and a half months after

dusting. The dusted insects fluoresce very brightly and can be watched at a distance of about ten feet.

The fluorescent compounds used were anthracene, 'Photophour' and standard 'Mazdalux' powders P_2, P_4 and P_{4XX}, P_5 and P_{5XX} and P_7, giving bright blue, green, yellow and red fluorescence. The ultra-violet lamp used was a 125-watt 'Mercra' lamp with a concentrating reflector. The dusting procedure is very simple. The mosquitoes are placed in a glass chimney and given a few puffs of the fluorescent dust by means of a hand duster. Aqueous suspensions of fluorescent compounds in spirit gum or slightly soluble dusts in standard cobalt salt solution are not recommended, as the spray accumulates on the wings only and the fluorescence is comparatively poor.

It has not been possible to develop an apparatus capable of working from a 6–12-volt battery; the standard 'Mercra' lamp used in these experiments works on 220 volts A.C.

I should like to thank the British Thomson-Houston Co., Ltd., for the loan of the apparatus, for supplying fluorescent compounds and for other technical assistance.

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'Evaporation' of Heavy Nuclei

THE behaviour of atomic nuclei under very high excitation can at present only be studied by examination of the nuclear disintegration 'stars' produced by high-energy cosmic ray particles. Below is given a brief account of results obtained in a preliminary examination of Ilford Nuclear Research emulsions exposed to the cosmic radiation.

Measurements have been made on the energy distribution of particles from the disintegration of fifteen heavy nuclei (silver and bromine), out of a total of some two hundred stars found on 400 sq. cm. of plate area. A star was assumed to be due to a heavy nucleus if the ejected particles carried a total charge of more than eight units, and was only accepted for measurement if at least one long proton track ended in the emulsion, so that the latent image 'fading' could be allowed for in determining track energies from grain counts.

In Fig. 1 the histogram indicates the energy distribution of a total of eighty star proton tracks. Such tracks in *B*2 and *C*2 emulsions become very difficult to detect at energies greater than 100–200 MeV.; hence the stars may well include protons (and mesons) of too high energy to be observed; but at energies less than 100 MeV. the proportion of tracks missed in detailed examination of the stars is believed to be very small.

The process leading to the emission of particles may be visualized as follows. When the incident cosmic ray particle strikes the nuclear surface, its energy is divided in the first instant of time among only a few nucleons. In most cases, the latter will then interact with other nucleons and produce a general 'heating up', until 'thermal' equilibrium is attained. The disintegration process is then analogous to the evaporation of a drop of liquid, and particles are ejected under arbitrary angles, as in Fig. 2. In the case of fairly heavy nuclei, an approximate theoretical treatment of the problem is possible from a thermodynamic point of view, and the energy spectrum of charged particles evaporating from a highly excited nucleus in 'thermal' equilibrium at temperature T is given by[1]

$$P(E)dE = \text{const.}\ \frac{(E-V)}{T^2}\ \exp\left\{\frac{-(E-V)}{T}\right\} dE, \quad (1)$$

where V is the potential barrier height. The value of T drops during the evaporation; also, the temperature depends, though fortunately not very critically, on the excitation energy, which will be different for every star. The average value of E from (1) is

$$\overline{E} = 2T + V, \quad (2)$$

so that it is possible to obtain a mean value of $\overline{T}$ for all stars by using the experimental value of $\overline{E}$. Cutting off the observed spectrum at $E = 40$ MeV. (for reasons apparent below), one finds $\overline{E} = 13$ MeV. The experimental distribution is then reasonably well represented by equation (1), choosing $V = 3$ MeV., so that $\overline{T} = 5$ MeV. (dashed line in Fig. 1). From the proportion of protons at the low-energy end of the histogram, one can conclude that in these pro-

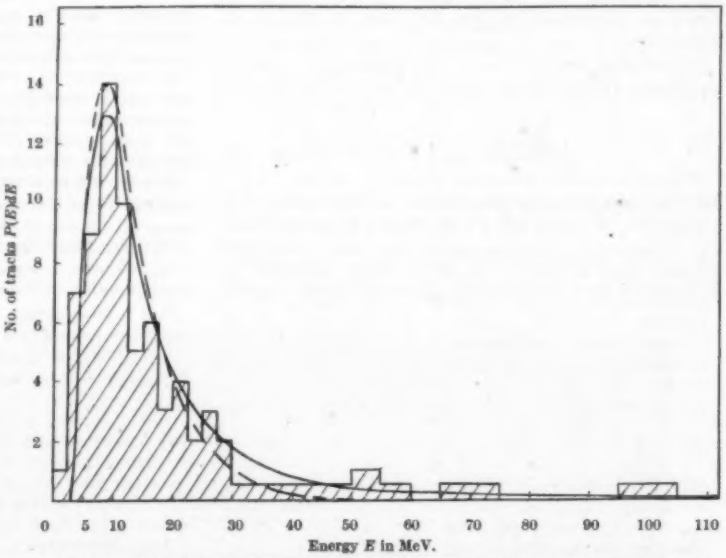

Fig. 1. ENERGY DISTRIBUTION OF PROTON TRACKS FROM DISINTEGRATION OF HEAVY NUCLEI. ORDINATES ON THE HISTOGRAM DENOTE THE NUMBER OF OBSERVED TRACKS PER 2·5 MeV. ENERGY INTERVAL, FROM 0 TO 30 MeV., AND HALF THE NUMBER OF OBSERVED TRACKS PER 5 MeV. INTERVAL FOR ENERGIES GREATER THAN 30 MeV. DASHED AND FULL CURVES CORRESPOND TO EQUATIONS (1) AND (3)

cesses the barrier height is in any case a very ill-defined quantity ($V = 6$ to 7 MeV. from the nuclear radius, as obtained by alpha-decay measurements).

Some 9 per cent of the tracks are due to protons having energies greater than 50 MeV. (for example, track B in Fig. 2), whereas according to (1) such tracks should form only 0·2 per cent of the total. It is therefore clear that the high-energy 'tail' of the spectrum is not explicable on the Bohr evaporation hypothesis. At least three of the seven tracks in question have sufficient length in the emulsion to identify them as due to protons, and it seems unlikely that the remainder were produced by slow mesons[2]. According to Heisenberg, these high-energy protons are produced as follows. On being struck by the incident particle, some of the particles on the nuclear surface would be expected to have their velocities directed outwards, and will therefore leave the nucleus immediately with a very high energy (especially if the incident particle strikes the nucleus at a 'glancing angle').

It has been found that this high-energy tail of the histogram can, for example, be represented by an expression of type (1), and the spectrum indicated by the full line in Fig. 1 is given by

$$P(E)dE = \left[\frac{(E-V)}{\overline{T}^2}\exp\left\{\frac{-(E-V)}{\overline{T}}\right\} + \frac{1}{4}\frac{(E-V)}{\tau^2}\exp\left\{\frac{-(E-V)}{\tau}\right\}\right]dE \quad (3)$$

for the energy-range considered (0–100 MeV.). A value of τ of about $4\overline{T}$ ($= 20$ MeV.) gives the best fit. 8 per cent of the spectrum then lies at energies greater than 50 MeV. It is, however, difficult to associate τ with temperature, since the latter fundamentally implies an equilibrium state, which is certainly not attained, even though the Heisenberg process may conceivably include ten particles or so.

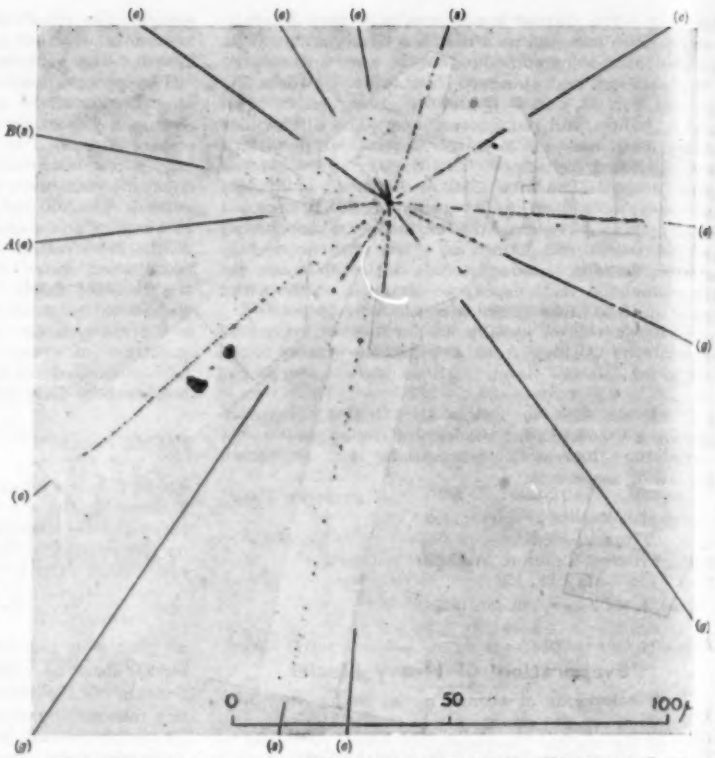

Fig. 2. Mosaic of 30 photomicrographs of typical star in 50 μ C2 emulsion. Leitz × 75 objective. At least 16 protons, α-particles and heavier particles (all tracks not shown) are ejected with various energies between 70 MeV. (track B) and 0·8 MeV. (track A). Tracks ending in the emulsion denoted by e, and those passing into the glass or out of the surface by g and s respectively

In addition to protons, about 25 per cent of the star tracks were due to alpha-particles; an accurate measurement of their energy distribution has not yet been possible, since the grain density along alpha-tracks changes only slowly with energy.

The average energy required to eject a proton or neutron from the nucleus is $\overline{E} + E_0$ ($E_0 = 8$ MeV. being the binding energy), so that assuming rather more than one neutron emitted for every proton observed, and including the alpha-particle tracks, the average value of the excitation energy $U \sim 300$ MeV.

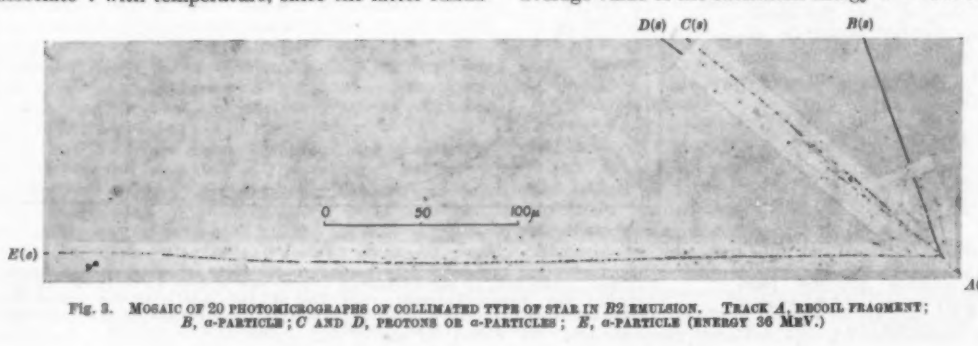

Fig. 3. Mosaic of 20 photomicrographs of collimated type of star in $B2$ emulsion. Track A, recoil fragment; B, α-particle; C and D, protons or α-particles; E, α-particle (energy 36 MeV.)

The Fermi gas and liquid-drop models lead to considerably higher energies (500 MeV. or more) for $\overline{T} = 5$ MeV.

It is interesting to note that in the pure Bohr type of process the particles should be emitted under arbitrary angles; however, the angular distribution of tracks in a number of the stars show marked deviations from spherical symmetry, and probably these disintegrations are characterized by the fact that thermal equilibrium is never fully attained. Fig. 3 shows an extreme example of such a star. The probability that all four tracks were ejected under arbitrary angles is calculated as less than 1 in 10^5. However, since the recoil nucleus shows considerable momentum, and the ejected particles are of relatively low energy (20 or 30 MeV.), it is doubtful if this process is of the pure Heisenberg type, as observed in cloud chambers[3].

I should like to express my sincere thanks to Dr. J. L. Michiels, for a valuable discussion of the above material.

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Adsorption Isotherms from Chromatographic Measurements

IT has been shown[1] that adsorption isotherms can be calculated with good accuracy from chromatographic data, utilizing the measured concentrations (c_v) of eluted solute after developing the original band with v c.c. of pure solvent. Use is made of the equation

$$q = f_{(c)} = (\mu_c + v.c_v)/x_l - \alpha.c_c, \quad . \quad (1)$$

where q is the amount of solute adsorbed per gm. of adsorbent, x_l is the total amount of adsorbent in the column (gm.), α is the pore space of the adsorbent (c.c./gm. adsorbent), μ_c is the total eluate after the point of concentration c.

In the case of strongly coloured solutes, however, where the movement of the front boundary of the chromatographic band can be followed easily, it is simpler to obtain the adsorption isotherm from the volume v of pure solvent used and from the amount of adsorbent x_f through which the coloured front has travelled from the top of the column.

The position of the front is governed by equation 1 in the form:

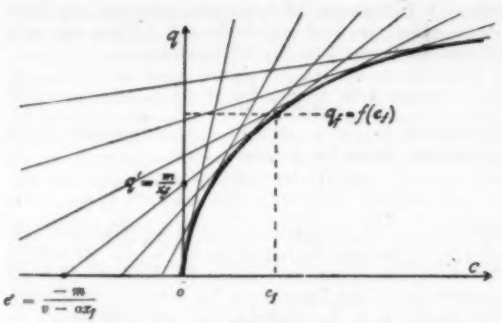
$$m = q_f.x_f - (v - \alpha x_f).c_f, \quad . \quad . \quad (2)$$

where m is the total amount of solute used. With m, v and x_f known, equation 2 represents a linear relationship between q and c with a gradient $dq/dc = (v - \alpha.x_f)/x_f$. However, as shown by De Vault[2] and by Weiss[3]

$$(v - \alpha.x_f)/x_f = [df_{(c)}/dc]_{c=c_f}.$$

Thus equation 2, taken as a function of the variables q and c, corresponds to the tangent to the adsorption isotherm $q = f_{(c)}$ at the point q_f, c_f, and, with a sequence of coexistent values of v and x_f, equation 2 gives a family of straight lines, from which the adsorption isotherm can be easily constructed as the envelope.

The relative accuracy of the equilibrium values so obtained is approximately that of v and x_f, which, for a well-made column, can be determined to at least ± 1 per cent. This method thus gives the complete adsorption isotherm without requiring a single concentration measurement by just following the movement of the front boundary, and this with an accuracy at least equal to that of the best classical methods of measuring adsorption equilibria.



ADSORPTION ISOTHERM AS ENVELOPE OF THE FUNCTION $m = x_f.q - (v - \alpha.x_f).c$

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Slip Flow in Granular Beds

THE Poiseuille type of equation for capillaries of any shape takes the form,

$$u_e = \frac{m^2}{k_0\eta} \cdot \frac{\Delta p}{L_e} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

for capillaries of any cross-section, where $k_0 = 2$ and $m = r/2$ for a circular capillary of radius r, and k_0 has generally values between 2 and 3 for other shapes[1]. Application of this to granular beds follows by putting $u = u_e \cdot \varepsilon \cdot L/L_e$, $m = \varepsilon/S\sigma(1-\varepsilon)$, $k = k_0 \cdot (L_e/L)^2$, whence

$$u = \frac{\varepsilon^3}{(1-\varepsilon)^2} \cdot \frac{\Delta p}{k\eta S^2\sigma^2 L} \quad . \quad . \quad . \quad (2)$$

k is known as Kozeny's constant, and is approximately equal to 5 [1,2], Δp is pressure drop in dynes/cm.^{2}, and other symbols are as in the paper of Lea and Nurse[2].

When slip takes place in a capillary, giving a velocity, u_s, at the wall, this must be added to the right-hand side of (1). Now, by balancing momentum transfer and pressure difference, Millikan[3] obtained an expression for u_s in a circular capillary in terms of a coefficient of external friction, β. In brief, tangential force on wall, $F' = 2\pi r L_e \beta u_s = \pi r^2 \cdot \Delta p$. This is readily generalized to non-circular capillaries, giving

$$u_s = \frac{m}{\beta} \cdot \frac{\Delta p}{L_e} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The Poiseuille type of equation, corrected for slip, thus becomes

$$u_e = \frac{m^2}{k_0\eta} \cdot \frac{\Delta p}{L_e} \cdot \left(1 + \frac{k_0\eta}{m\beta}\right) \quad . \quad . \quad (4)$$

Millikan further showed that β is given by

$$\beta = \tfrac{1}{2}\rho\bar{c} \div \left(\frac{2}{f} - 1\right) \quad . \quad . \quad . \quad (5)$$

where f is fraction of molecules striking capillary walls which are diffusely reflected. Thus the slip correction factor $1 + k_0\eta/m\beta$ becomes

$$1 + \frac{2k_0\eta}{m\rho\bar{c}} \cdot \left(\frac{2}{f} - 1\right) \quad . \quad . \quad . \quad (6)$$

By substituting $m = \varepsilon/S\sigma(1-\varepsilon)$ this becomes a slip correction factor for granular beds,

$$1 + \frac{S\sigma(1-\varepsilon)}{\varepsilon} \cdot \frac{2k_0\eta}{\rho\bar{c}} \cdot \left(\frac{2}{f} - 1\right) \quad . \quad (7)$$

which must be multiplied into the right-hand side of (2). The first introduction of a slip correction factor of this form was made by Rigden[4], but he applied it in the form used for circular capillaries, for which $k_0 = 2$, whereas, for granular beds, k_0 appears to lie between 2·5 and 3, that is, the correction should be larger than that used by Rigden. Lea and Nurse[2] adopted the Chapman equation for viscosity, $\eta = 0{\cdot}5\ \rho\bar{c}\lambda$, where λ is molecular mean free path, in which case (7) takes the form

$$1 + \frac{S\sigma(1-\varepsilon)}{\varepsilon} \cdot k_0\lambda \left(\frac{2}{f} - 1\right) \quad . \quad . \quad (7a)$$

but wrote it in the form

$$1 + \frac{S\sigma(1-\varepsilon)\ Z\lambda}{\varepsilon} \quad . \quad . \quad . \quad . \quad (7b)$$

and evaluated Z experimentally, finding values between 2·73 and 4·07, averaging about 3·3.

By comparing (7a) and (7b), it can be seen that

$$Z = k_0 \left(\frac{2}{f} - 1\right)$$

Now, Rigden used Millikan's value, $f = 0{\cdot}89$; but recently Brown, DiNardo, Cheng and Sherwood[5] have shown that $f = 0{\cdot}84$ is a more acceptable value in circular capillaries. It is of interest to calculate Z for both values of f and for $k_0 = 2$, 2·5 and 3.

f \ k_0	2·0	2·5	3·0
0·89	2·50	3·12	3·75
0·84	2·76	3·45	4·13

Thus, on the whole, values of k_0 between 2·5 and 3 give better agreement with experiment than Rigden's assumption that $k_0 = 2$.

It is important to note here that there is no need to introduce a mean free path into (7), and that it is better to express it entirely in terms of experimental quantities by substituting

$$\bar{c} = \sqrt{\frac{8}{\pi} \cdot \frac{RT}{M}}$$

giving

$$1 + \frac{S\sigma(1-\varepsilon)}{\varepsilon} \cdot \sqrt{\frac{\pi M}{2RT}} \cdot \frac{k_0\eta}{\rho} \cdot \left(\frac{2}{f} - 1\right) \quad . \quad (7c)$$

It should also be noted that, if Δp is a large fraction of the initial pressure, u must be replaced by the mass velocity, $G = \rho u$, and equation (2) is easily shown to assume the form

$$G = \frac{\varepsilon^3}{(1-\varepsilon)^2} \cdot \frac{\rho_m \Delta p}{k\eta S^2\sigma^2 L}, \quad . \quad . \quad . \quad (8)$$

where ρ_m is the mean gas density before and after the bed and is equal to $\frac{1}{2}(\rho_1 + \rho_2)$. At the same time, ρ_m must be substituted for ρ in all the slip factors (7).

Molecular Flow of Gases in Granular Beds. When, in (7b),

$$\frac{S\sigma(1-\varepsilon)Z\lambda}{\varepsilon} \gg 1, \text{ that is, } \frac{Z\lambda}{m} \gg 1,$$

slip flow passes to molecular flow and the unity term in slip factors (7) can be neglected. Multiplying the second term of factor (7c) into the right-hand side of equation (8), we get

$$G = \frac{k_0}{k} \cdot \sqrt{\frac{\pi M}{2RT}} \cdot \left(\frac{2}{f} - 1\right) \cdot \frac{\varepsilon^3}{(1-\varepsilon)S\sigma} \cdot \frac{\Delta p}{L} \quad (9)$$

This differs from the equation put forward by Holmes[6] in two respects: (i) a factor k_0/k is introduced, which we have seen equals $(L_0/L)^2$ and appears generally to lie between 1·5 and 2. (ii) A factor $\sqrt{\frac{\pi}{2}} \cdot \left(\frac{2}{f} - 1\right)$ takes the place of $\frac{8}{3}\sqrt{\frac{2}{\pi}}$. Since Brown, DiNardo, Cheng and Sherwood find $f = 0{\cdot}77$ best fits molecular flow in circular capillaries, the two expressions are about equal.

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High-Frequency Permeability of Ferromagnetic Materials

In view of the possibility of obtaining fuller information about the domain structure of ferromagnetics, by measurements of permeability at high frequencies, a method has been developed of measuring the effective reversible permeability of ferromagnetic materials in wire form over a fairly wide range of frequencies. A comprehensive review of earlier work has been given by Allanson[1], and apart from the early work of Arkadiew[2], who used a spark-gap source, no measurements of permeability have been recorded at frequencies higher than about 2,000 Mc./s.

Of the methods suggesting themselves for measurements at microwave frequencies, reflexion methods were found to be unsuitable[3] for metallic conductors, and the measurement of Q-factors of ferromagnetic films seemed to present experimental and theoretical difficulties.

In our method the permeability is deduced from measurement of the difference, $\Delta\alpha$, in the attenuation constant of a coaxial transmission line when the inner conductor, made of the ferromagnetic material under test, is replaced by a non-magnetic material of the same dimensions. It may be shown that

$$\Delta\alpha = \text{constant} \times \left(\sqrt{\frac{\mu}{\sigma_1}} - \sqrt{\frac{1}{\sigma_2}}\right),$$

where σ_1 and σ_2 are the conductivities of the ferromagnetic and non-magnetic materials respectively, and μ is the permeability.

The attenuation constants are determined from standing-wave measurements for different reactive terminations and are deduced directly from a circle diagram[4]. A pulsed oscillator is used to enable amplification of the rectified signal and accurate measurement of standing-wave ratios between 1 and 100 to be made. The method is rapid in operation

and particularly suitable for use in the microwave region between about 2 and 20 cm. The present measurements, however, have been restricted to those frequencies for which suitable oscillators could be obtained.

Results have been obtained over the range from 8 to 14 cm., on a low-carbon content iron wire (0·04 per cent carbon), and a steel wire (0·50–0·55 per cent carbon), both specimens being tested in the hard-drawn (bright) condition and also after white annealing. Measurements have also been made with a commercial nickel wire (higher than 99·5 per cent nickel). The results, together with the D.C. initial permeabilities, are given in the accompanying table:

Frequency (Mc./s.) Wave-length (cm.)	D.C.	2300 13	2600 11·5	3000 10	3400 8·8
Iron, bright	101	50	65	63	61
Iron, white annealed	140	41	60	67	65
Steel, bright	65	38	34	39	25
Steel, white annealed	102	31	31	28	28
Nickel	13	7	8	10	8

The probable error in these results is of the order of 10 per cent.

The measurements are now being extended to other frequencies and ferromagnetic materials. A fuller account of these measurements, together with their bearing on the theoretical considerations advanced by Becker[5] and Kittel[6], will be published in due course.

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Decay of Luminescence due to Forbidden Optical Transitions

It is well known that the exponential, temperature-independent decay of luminescence in solids such as sulphides and silicates of zinc and ruby is characteristic of forbidden optical transitions within the specific luminescence emission centres, and the mean life-time of such decays can be of the order of milliseconds in these materials[1,2]. The nature of these transitions in the chromium centres of ruby has been thoroughly studied by Thosar[3], and the resulting decay of luminescence by Garlick and Wilkins[3]. In 1943, Dr. A. F. Wells, working in this laboratory, found that manganese centres in certain fluoride crystal lattices produced such decays with time constants of the order of 10 sec.$^{-1}$, that is, the mean decay time being 100 msec.

We have recently studied the function of rare earth impurity in some silicate phosphors, and find that the emission centres formed by inclusion of europium ions in strontium silicate give rise to an exponential decay of luminescence which is independent of temperature (experimental range 90°–600° K.) and has a mean life-time of 2·3 sec., this decay being preceded by a faster component of very short life-time. Both components appear for excitation by 3650 A. and by 2537 A., but in addition the shorter wave-length produces a long-duration exponential decay of phosphorescence which is strongly dependent on temperature and is associated with a thermoluminescence characteristic of a single depth of electron trap of 0·75 eV. as derived from the relations developed by Randall and Wilkins[4]. Excitation by the short wave-length also causes photoconduction, but this is not closely associated with the luminescence processes in the material. Under all wave-lengths of excitation the emission spectrum consists of a broad band in the visible region with maximum in the green, and does not compare with the usual spectra of salts and solutions of salts of europium[5].

So far, studies have been of a preliminary nature and little is known of the location of the europium ion in the silicate lattice. The studies of electron trapping show that the traps are specific to the centres and may be either within each centre or very near it. The efficiency of the luminescence is about 0·1 of that for a willemite phosphor excited by the short wave-length of 2537 A.

We have found such low transition probabilities in dye molecules when adsorbed on to solid surfaces after the method of Travnicêk[6], the mean life-times being of the order of 1·6 sec. for such molecules as carbazol, æsculin and phenanthrene. Such decay processes may also be followed by a temperature-dependent decay of longer duration.

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Bond-Strengths of Methyl-Iodine and Methyl-Magnesium

The heats of the following reactions in ether solution have been determined calorimetrically:

$$CH_3 - MgI + I_2 = CH_3I + MgI_2 - 45{\cdot}4 \pm 1{\cdot}0 \text{ kcal.}$$
$$2CH_3 - Mg - I + I_2 = C_2H_6 (g) + 2MgI_2 - 103{\cdot}4 \pm 3 \text{ kcal.}$$

Using these values, and published data[1] for the heats of atomization of solid iodine, for the bond-strength $D(CH_3-CH_3)$ and for the latent heats of volatilization of ethyl ether and methyl iodide, the bond-strength is calculated

$$D(CH_3 - I) = 54{\cdot}75 \pm 1{\cdot}4 \text{ kcal.},$$

in good agreement with the value of 54 kcal. obtained from kinetic data[2].

A (less reliable) value of the bond-strength

$$D(CH_3 - Mg) = 67{\cdot}0 \text{ kcal.}$$

can also be computed from the calorimetric data.

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DIFFRACTION OF X-RAYS BY THE ALLOY $AuCu_3$

THE alloy $AuCu_3$ has an ordered structure below 391° C. If a disordered alloy is heat-treated below this temperature, superlattice lines appear on X-ray powder photographs, and the development of the perfectly ordered structure can be followed by observation of these superlattice lines; they are diffuse at first and increase in sharpness as the heat-treatment progresses, until they become as sharp as the main lines.

A simple explanation of this phenomenon is that the domains of similar order (anti-phase domains) are initially much smaller than the crystal grains in which they exist; on this basis, Jones and Sykes[1] showed that it should be possible to derive the sizes of the anti-phase domains from the breadths of the superlattice lines. Detailed investigation showed, however, that different lines gave different results, and the problem remained unsolved.

Wilson[2] has produced a method of calculating the diffraction effects given by such an alloy, and has shown that the breadths of the various superlattice lines will be dependent upon the way in which one domain is bounded by its neighbours; he tried the effect of imposing certain conditions on the boundaries and found one model that gave fair agreement with Jones and Sykes' results. He pointed out, however, that it was possible that other models may give as good agreement or even better.

We have attempted to test Wilson's theory by taking X-ray oscillation photographs of a single crystal; such photographs contain much more evidence than powder photographs and so should provide a much more stringent test of the theory. Similar considerations have led Strijk and MacGillavry[3] also to carry out experimental work on a single crystal to test a theory of their own[4]. Their theory is rather different from Wilson's, and their experimental results do not fit in perfectly with either. We believe, however, that their experimental methods are not well suited to differentiate between the two theories, as the following considerations show. MacGillavry and Strijk's theory would lead to sharp reciprocal points for the main reflexions and diffuse spots all of the same shape and with cubic symmetry for the superlattice reflexions; Wilson's theory leads to a more complicated representation which is shown in Fig. 1. MacGillavry and Strijk used a rod-like crystal with its length approximately in the [110] direction, and they investigated the distribution of intensity only in the plane perpendicular to [110]. Therefore, they have not checked that the spots have cubic symmetry, as their theory demands; nor have they disproved Wilson's theory, since this leads to similar shapes for all spots with $h + k = 0$.

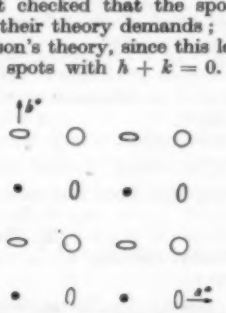
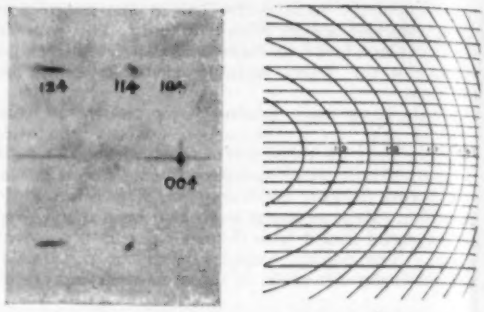


Fig. 1. RECIPROCAL LATTICE OF $AuCu_3$, ACCORDING TO WILSON'S THEORY



a b

Fig. 2 *a* and *b*. PORTION OF OSCILLATION PHOTOGRAPH OF $AuCu_3$ AND CORRESPONDING PORTION OF BERNAL CHART

Our crystal is smaller than that used by MacGillavry and Strijk; it gives main reflexions that are quite small, and so the shapes of the superlattice reflexions stand out clearly. Preliminary results show qualitative agreement with Wilson's theory; this is shown by Fig. 2, which is part of an oscillation photograph about the [100] axis.

It will be seen that the spots are not all of the same shape; for example, 114 is elongated at an angle to the layer line and 124 is elongated along the layer line. Such an effect cannot be produced by differences in the geometrical conditions for reflexion due to difference in θ. Moreover, the slope of the spot 114 is about the same as that of the curves on the Bernal chart (Fig. 2*b*) at the same point, which means that the elongation is parallel to one of the reciprocal axes. In this respect, the results are in accordance with the reciprocal lattice shown in Fig. 1.

Oscillation photographs do not provide a complete test, as the spots recorded represent projections of the reciprocal-lattice spots on to a plane. We are, therefore, undertaking a more detailed investigation of sections of the spots, and this should provide quantitative evidence by means of which the two theories can be adequately tested.

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IN treating the integral breadths of the lines in the powder photographs of $AuCu_3$ obtained by Jones and Sykes[1], it was not necessary to consider the actual shapes of the regions of high intensity in the reciprocal lattice, the apparent particle-size of the hkl reflexion being given directly by

$$\varepsilon = (J_0 V_0)^{-1} \int V_t J_t dt, \qquad (1$$

where V_t is the volume common to the crystal and its 'ghost' shifted a distance t in the hkl direction and J_t is the mean value of the product FF^* for two cells separated by a distance t in the hkl direction[2]. The distribution of intensity in the reciprocal lattice may be obtained from the same functions. If a, b, c

are the cell edges, U is the volume of the unit cell, $V(x, y, z)$ and $J(x, y, z)$ are the values of V and J corresponding to the displacement xa,yb,zc, and ua^*,vb^*,wc^* are distances measured from the point hkl of the reciprocal lattice, the intensity of reflexion is proportional to

$$H(u,v,w) = U^{-1} \iiint V(x,y,z)\, J(x,y,z) \exp\{2\pi i\,(ux+vy+wz)\}\, dxdydz. \quad (2)$$

This expression was derived in connexion with line broadening in hexagonal cobalt[2], where, however, it was written in the form of a summation. In many cases the variation of V, or $V(x,y,z)$ can be neglected in comparison with the more rapid variation in J, or $J(x,y,z)$.

Equation 2 can be evaluated for several of the models suggested[3] for the occurrence of mistakes in $AuCu_3$. For the fifth model, in which gold atoms avoid one another, it gives[4]

$$H(u,v,w) = N(\text{Au-Cu})^2 : \frac{\alpha}{\alpha^2+\pi^2u^2} \cdot \frac{\alpha}{\alpha^2+\pi^2v^2} \cdot F(w) \quad (3)$$

for the superlattice reflexions having h and k both odd or both even; if k and l or l and h are both odd or both even, the variables u,v,w are appropriately permuted. The factor $F(w)$ is the 'normal' variation of intensity in the reciprocal lattice, being practically zero for w differing appreciably from zero, and α is the probability of a mistake in a distance a. This leads to the type of reciprocal lattice pictured by Edmunds, Hinde and Lipson[5]. For the sixth model, which is similar except that the gold atoms merely tend to avoid one another, the integrations necessary to evaluate Equation 2 cannot be easily performed, but qualitatively the effect will be to give the disks a finite thickness, the relative amount of the thickening depending on the ratio of the probability α of a mistake in which gold atoms avoid one another to the probability γ of a mistake in which they do not.

This model thus accounts qualitatively for the results of Strijk and MacGillavry[6] and of Edmunds, Hinde and Lipson. It is possible to make a semi-quantitative comparison with the former, since they use their experimental data to evaluate the function $J(x,y,z)$, or rather the section of it by the plane $y+z = 0$, for reflexions of the type $hk\bar{k}$. The theoretical value of J for these reflexions is[3]

$$J(x,y,z) = (\text{Au-Cu})^2 \exp\{-2\alpha(|y|+|z|) - 4\gamma r/3\}, \quad (4)$$

where $r^2 = x^2 + y^2 + z^2$. In polar co-ordinates in the section evaluated

$$J(r,\theta) = (\text{Au-Cu})^2 \exp\{-(2\sqrt{2}\alpha\,|\sin\theta| + 4\gamma/3)r\}, \quad (5)$$

which may be compared with the contours given in Strijk and MacGillavry's Fig. 7. Equation 5 suggests that the contours of constant J will all be of the same shape, given by

$$r^{-1} = 4\gamma/3 + 2\sqrt{2}\alpha\,|\sin\theta|, \quad (6)$$

and that their sizes will be proportional to $\log J$. The contours obtained by Strijk and MacGillavry, normalized to $r = 1$ for $\theta = 45°$, lie within the area shaded in Fig. 1, so that there is little variation in shape. The full line is the curve given by Equation 6, the values of α and γ obtained from Jones and Sykes' powder photographs being used. The agreement is fair, being about as good as that obtained experimentally for different reflexions. In Fig. 2 $\log J$ is plotted against the actual radii for $\theta = 45°$. A straight line can be drawn through the points for the smaller values of J, those for the larger lying below it. Strijk and MacGillavry give reasons for supposing that the larger values of J are too low, so that their experiments are not inconsistent with the model proposed to explain the powder photographs of Jones and Sykes.

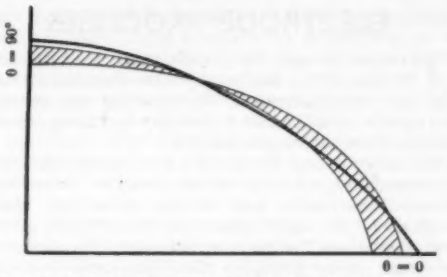

Fig. 1. Shapes of experimental (shaded area) and calculated (full line) curves of constant J

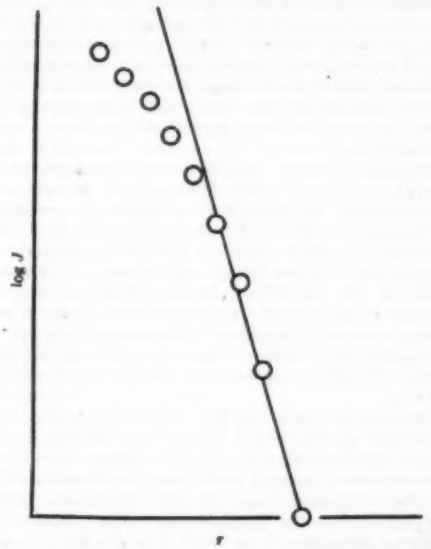

Fig. 2. Experimental (circles) and calculated (full line) mode of variation of log J with r

Further work is necessary, however, to establish the correctness or otherwise of this model. It is somewhat difficult to imagine the internal state of a crystal containing mistakes both on 100 planes, such that gold atoms do not come into contact, and on random planes, with no avoidance by the gold atoms. It may be necessary to modify the assumption that the probability of a mistake in any interval is independent of the position of other mistakes.

A. J. C. Wilson

University College,
Cardiff.
April 18.

[2] Jones F. W., and Sykes, C., *Proc. Roy. Soc.*, A, **166**, 376 (1938).
[3] Wilson, A. J. C., *Proc. Roy. Soc.*, A, **181**, 360 (1943).
[4] Wilson, A. J. C., *Proc. Roy. Soc.*, A, **180**, 277 (1942).
[4] Wilson, A. J. C., "X-Ray Optics" (London: Methuen and Co., in course of publication).
[5] Edmunds, I. G., Hinde, R. M., and Lipson, H., preceding communication.
[6] Strijk, B., and MacGillavry, C. H., *Physica*, **12**, 129 (1946).

ELECTRODE PROCESSES

ON April 9 and 10 a discussion on "Electrode Processes" arranged by the Faraday Society was held at Manchester. The meeting was attended by nearly two hundred people, including several distinguished overseas visitors.

Faraday Society discussions have often marked an important stage in the development of branches of physical chemistry, and it was at a very timely moment in the development of the subject of electrode processes for such a discussion to take place. It seems to be probable that the most important advance in experimental physical chemistry in the next decade will lie in the application to the science of the techniques of electronic engineering, developed particularly during the War, and the field of electrode processes may be one which will yield readily to attack by the new weapons; in fact, a most promising start has already been made. For this reason, a review of the subject at this stage will undoubtedly give great impetus to development along the more important lines.

Altogether, forty papers were presented at the meeting, and they were discussed in groups under the headings "General", "Hydrogen Overvoltage", "Deposition of Metals", "Oxygen Overvoltage" and "General Anodic Processes and Cell Reactions". An introduction to the whole discussion was given by Prof. W. F. K. Wynne-Jones (Dundee), and the various sections were introduced by Prof. Wynne-Jones, Dr. A. Hickling (Liverpool) and A. W. Hothersall (Woolwich). The president, Prof. W. E. Garner (Bristol), was in the chair throughout the meeting.

The subject of hydrogen overvoltage was taken first, and at this stage Prof. A. L. Ferguson (Ann Arbor) directed attention in his paper to the many unsolved fundamental problems associated with the interface between electrode and electrolyte, and to the difficulties in interpreting data obtained by different methods.

A communication by Prof. A. Frumkin (Moscow) discussed the mechanism of hydrogen discharge on the basis of extensive experimental work. The data are interpreted as proving that the discharge of hydrogen ions is the slowest stage in the evolution of hydrogen from acid solutions on mercury, but that subsequent stages, for example, the combination of hydrogen atoms to form molecules, may assume importance with low overvoltage cathodes. The slow-discharge theory was the basis of a theoretical contribution by Dr. J. Weiss (Newcastle-on-Tyne), in which the discharge was considered as the transfer of a proton from the hydrated to the surface-adsorbed state. In a lively discussion the slow-discharge theory was strongly criticized by some speakers, one of the points raised being the apparent absence of a satisfactory relation between the work function of the metal and the value of the overvoltage. The chief alternative theory is the slow combination of hydrogen atoms at the cathode. It was regrettable that Prof. Frumkin was unable to be present in order to contribute to the discussion on this controversial issue. Prof. Garner suggested that a compromise between the two theories would probably be more satisfactory than either of them taken by itself.

J. N. Agar (Cambridge) suggested an analysis of overvoltage data in the manner adopted for rate constants, deriving a 'heat of activation' and an 'entropy of activation', as an examination of these parameters might throw some light on the possible discharge mechanism.

Dr. F. P. Bowden (Cambridge) and K. E. W. Grew (Cambridge) presented data on overpotential measurements at very low current densities on mercury which demonstrate that Tafel's equation, whatever its general validity, is in any event closely obeyed by mercury cathodes over the current density range 10^{-10}–10^{-3} amp./cm.^{2}. The same authors re-investigated the capacity of the double layer on mercury in sulphuric acid solution by the charging-time method. Their value (20 μf./cm.^{2}) is in close agreement with measurements by different procedures, but considerably higher than previous values obtained by the same method. It was pointed out in the discussion that, in spite of the agreement between different determinations, the uncertainty in the value of this quantity is still considerable, for example, a value of 12 μf./cm.^{2} was preferred by Dr. Hickling.

The behaviour of palladium electrodes during the discharge of hydrogen was the subject of a paper by H. P. Stout (Saltcoats). P. M. Bryant (Bristol) and G. E. Coates (Bristol) described an investigation of the polarization of platinized platinum electrodes, where an ageing effect of the electrodes was discovered. Periodic changes in the behaviour of anodically polarized platinum electrodes were discussed by Dr. J. A. V. Butler (London) and G. Armstrong.

In the group of "General" papers the subject of diffusion at the electrodes, of importance in the theory of concentration polarization, was treated mathematically by J. N. Agar and by B. Levich (Moscow). The kinetics of rapid electrode reactions have been studied experimentally by J. E. B. Randles (Birmingham), the analysis of the results leading to values for rate constants of electrode reactions.

In an important theoretical contribution, T. B. Grimley (Bristol) and Prof. N. F. Mott (Bristol) calculated from first principles the potential difference at the interface between a solid and an ionic solution, the example chosen being that of the silver–silver bromide electrode.

There were several papers on the cathodic deposition of metals. The relation between the structure of the deposit and the conditions of deposition was examined by electron diffraction experiments by Prof. G. I. Finch (London), H. Wilman (London) and L. Yang (London). Two communications by T. P. Hoar and J. N. Agar dealt with the theoretical analysis of electrical conditions in plating baths. Polarization in the electrodeposition of metals was discussed by G. E. Gardam (London), who showed that the physical form of the cathode metal deposit may influence the polarization, the cause being the difficulties of disposing of the new atoms in the grain lattice.

The mechanism of cathodic metal deposition was investigated by Prof. J. Heyrovský (Prague), using a new modification of the polarographic technique by which electrodeposition involving an irreversible discharge may be recognized. The results show that all one-electron discharges are reversible, but that most processes with more than one electron transfer are irreversible; and it is deduced that the electrons are transferred successively.

The first paper on the subject of anode processes was contributed by Dr. A. Hickling, who directed attention to anomalies observed in some anodic reactions; for example, the Kolbe reaction, where processes occur at a high positive potential in pre-

ference to other possible reactions requiring a lower potential. There was considerable discussion on this, the question being whether the phenomenon could be explained by some specific adsorption mechanism, or whether a more fundamental electrochemical problem was raised by it.

A number of contributions dealt with determinations of oxygen overvoltage. A considerable degree of reproducibility has been achieved in some of the studies ($\pm$ 0·01 to $\pm$ 0·03 V.), but agreement between different laboratories is not yet satisfactory. It was urged earlier in the discussion by Sir Charles Goodeve that in overvoltage measurements more attention should be given to the influence of the procedure of measurement on the results. The effect on the oxygen overvoltage of electrode material current density and time for aqueous solutions was examined by Dr. A. Hickling and S. Hill, and that of solvent variation (also on hydrogen overvoltage) by Dr. J. O'M. Bockris (London).

The last group of papers was devoted to other anodic processes and cell reactions in general, several communications dealing with anodic polarization of metal electrodes by surface oxides. M. Haïssinsky (Paris) pointed out that hydrogen peroxide oxidations may lead to chemically different products from anodic oxidations, which does not agree with the general theory of intermediate hydrogen peroxide formation in anodic oxidations.

An interesting contribution by Prof. H. J. C. Tendeloo (Wageningen) showed that electrode potentials are not only of applied but also of direct interest to biologists, and presented data about the application of electrochemical theory to calculate the potentials of plant roots.

A brief summary of this kind cannot, of course, lay claim to either completeness or even impartiality in the selection of the points reported in it; but the complete proceedings of the meeting, including the papers read and remarks made in discussion, will be published in the *Transactions of the Faraday Society* as Volume 43 A (1947).

V. Gold

MILK, TINNED FOODS AND BREAD

At the Health Congress of the Royal Sanitary Institute recently held at Torquay, Section E (Food and Nutrition) met jointly on June 6 with the Food Group of the Society of Chemical Industry. Three papers were given at this session, each dealing with an important and topical aspect of food in relation to health. Prof. H. D. Kay (president of the Section) directed the attention of the meeting to the slow decline, that began some years before the War and was acutely accentuated during the winter months of the war years, in the compositional quality, and therefore in the nutritional value to the consumer, of market milk. The only reason for the existence of the milk industry is the fact that cows' milk is a valuable human foodstuff. Anything, therefore, causing a decrease in its nutritional value is of major importance not only to the consumer but also to all engaged in the industry, whether producers or distributors.

The insidious but now well-established decline which began to declare itself some years before the War is a diminution both in the fat and the non-fatty solids content of milk (when figures are averaged over the year). This amounts to an increase in its water content; but it is not due to adventitious watering—experimental surveys have shown that there are few indeed of the farmers of Great Britain who are guilty of extending the volume of the milk in this way. The main cause of this slow decline is the increased use, in breeding, of what Prof. Kay called 'watery' bulls, that is, bulls selected merely on account of the high milk yields of their female relatives, without regard for the *quality* of the milk. 'Watery' bulls of both the Friesian and the Shorthorn breeds are involved; the rapid increase in recent years in the number of relatively poor-quality Friesian bulls is well known.

As regards the acute fall in non-fatty solids to well below the 'legal' presumptive limit of 8·5 per cent, a fall which occurred during the late winter months (January to April) in very many herds during the War years and since, and which reached in April 1947, in some districts, the lowest figures yet recorded, it has been conclusively demonstrated by experiments at the National Institute for Research in Dairying during the past two years that the main cause is a deficiency of winter feeding-stuffs. It is in the valuable proteins of the milk that this compositional defect is most apparent, and not in the fatty portion. An unexpected finding is that shortage of energy (calories or 'starch equivalent') in the cows' diet is more serious in its effects in diminishing the milk protein than is shortage of protein, provided the diet contains sufficient energy. The level of non-fatty solids in the milk returns to normal, or even goes above normal, within a few days of the cows going out to grass in the spring.

Prof. Kay suggested that the quickest and most satisfactory way of reversing the slow decline in average milk quality would be to pay milk producers on the basis of compositional quality and not, as at present, merely on volume. The suggested method of payment, which is already applied in several countries abroad and presents no insuperable difficulties, would reimburse the dairy farmer for making those changes in breeding and management of his herd which would, if persisted in over a few years, achieve again the higher milk quality so desirable from the point of view of human nutrition. The acute fall in *winter* milk quality, which even to-day does not occur in adequately fed, well-managed herds, can only be dealt with by an improvement in the supply of winter feeding-stuffs. Even if more high-energy concentrates can be imported—and Prof. Kay thinks that every endeavour should be made to increase such imports—it will also be necessary to improve the quality and quantity of home-produced fodders for winter consumption, such as high-quality hay, silage made from young grass or from cereal-legume mixtures, kale, kale silage, dried grass, etc. A great deal can still be done in this direction on a very large number of dairy farms.

Mr. Stewart Swift (Oxford) spoke of the increasing anxiety with which public health and sanitary authorities are viewing the steady decline in milk quality; it concerns them not only from the point of view of human nutrition but also on legal grounds. He hoped that no time would be lost in applying the lessons derived from the surveys and the experimental work. Principal A. W. Ling (Seale Hayne) mentioned work carried out under his direction in the Bristol Province on the relation between low-quality hay and the decrease in the compositional

quality of milk; but emphasized the very serious difficulties under which the present-day dairy farmer is labouring.

The present state of our knowledge regarding certain major microbiological problems of the food canning industry was discussed by Mr. T. E. Bashford (London). The ideal heat process for any given canned food is one which, while of sufficient duration and temperature to render the product 'commercially sterile', yet has a minimal effect on its quality, nutritional value and on the attractiveness of its flavour. 'Commercial sterility' does not mean absolute sterility, since the finished pack may contain viable spores of thermophilic bacteria which do not give rise to difficulties so long as the cans are marketed under ordinary conditions of climate. Two main factors determine the adequacy of a process, namely, the rate of penetration of heat into the least accessible part of the contents of the can, and the thermal death-time of the most resistant of the organisms capable of causing spoilage or danger to health. The thermal death-time curve for *Cl. botulinum*, the most heat-resistant and dangerous of the food-poisoning organisms, has been very carefully determined, and in practice it has been found normally satisfactory if the heat exposure, determined as regards temperature by that reached in the slowest-heating portion of the can, has a 'lethal value' about three times that needed to destroy *Cl. botulinum*. In some cases, particularly where the pack has to go to tropical or semi-tropical countries, six to seven times the minimal lethal conditions for *botulinum* are used.

Mr. Bashford described how 'lethal rates' and 'lethal values' are determined, and showed how accurate determination of temperatures, at any part of a can during processing, can be carried out by means of thermocouples inserted into the pack before autoclaving. He also dealt with post-processing infection of the can contents through minute holes which are sometimes left, particularly if the dimensions of cover and body do not conform to quite close mechanical tolerances, when the cans are being sealed. Organisms from the cooling water or from the air may be drawn through the defective seams as the internal pressure of the can falls during cooling. As a precautionary measure, chlorination of the cooling water is now extensively used in canneries, with marked reduction in the proportion of cans that become 'blown'. The importance was stressed of the highest possible degree of microbiological cleanliness, not only in the food and other raw materials, such as sugar, before canning, but also in the whole of the canning plant.

The realization by progressive millers and bakers of the same need for microbiological cleanliness was mentioned by Dr. E. C. Barton-Wright, who gave an interesting account of some microbiological aspects of flour-milling and baking. Beginning with the quern, which was a type of property having a very special legal position in ancient society, Dr. Barton-Wright spoke of the evolution of power-driven mill stones and then of the sudden change, some seventy years ago, to the equivalent but fundamentally very dissimilar machinery which, with further modifications, carries out the modern, complicated process of flour milling. The all-important factor in the prevention of microbiological spoilage of wheat or flour is the moisture content, and experimental work in this field was described in some detail. Whereas wheat can be stored for long periods with complete safety at moisture content less than 16 per cent, with flour the conditions are more complex. Though moulds do not grow in flour which has a moisture content of less than 16 per cent, they nevertheless remain metabolically active when the moisture content is between 16 and 14 per cent, and will attack first the saturated acids and later the unsaturated fatty acids in the fat or oil naturally present in the flour, with disastrous results as regards baking quality and flavour. The metabolic activity of the moulds ceases below about 14 per cent moisture, but there is a danger of oxidative rancidity setting in if the moisture content is too far reduced, particularly in high-extraction flours. It is better, therefore, to store flour at a moisture content between 11 and 12 per cent, when the keeping life of a strong white flour under reasonably cool conditions may be as long as ten years. Even high-extraction flours, for example, National flour of 85 per cent extraction, will keep its quality under these conditions for several months.

Dr. Barton-Wright discussed the conditions controlling the growth of moulds on and in baked loaves. Mould infection is almost always external, and simple precautions in the bakehouse, the delivery van and the home should prevent it. The methods of prevention of the troublesome bacterial disease of bread known as 'rope', usually caused by *B. subtilis* spores in the flour which are not destroyed by the baking process, was described. More acid conditions during baking tend to prevent, and less acid conditions to foster, an outbreak of 'rope'.

A lively discussion followed, in which Mr. C. Ash (Coventry), Dr. J. Sword (Glasgow), Mr. D. H. F. Clayson (London), Mr. Hooper (Bristol) and others took part. It ranged over the effect of mastitis on milk quality, the alleged maldistribution of feeding stuffs for milk production, the absence of 'rope' in Scotland as a result of the more acid doughs used there, and the occasional presence in canned and preserved food of heat-stable toxins of bacterial origin.

WAR-TIME DEVELOPMENTS IN METALS AND ALLOYS

THE tenth Edward Williams lecture to the Institute of British Foundrymen was given by Sir Edward Appleton on "New Metals for Old". After a general discussion of the metallic state, Sir Edward discussed a number of aspects of metallurgy on which new light had been thrown in recent years.

The development of materials for war purposes has led to the introduction of new alloys, of which a steel containing carbon 0·4 per cent, nickel 13·5 per cent, chromium 13·5 per cent, tungsten 2·5 per cent, molybdenum 1·8 per cent, cobalt 10·5 per cent, niobium 3·4 per cent, may be mentioned as typical. This steel, developed for high-temperature services in the gas turbine, has a creep-rate of 0·2 per cent in 100 hours under a load of 5 tons per square inch at 800° C. Improvements in the nickel–chromium alloys have been effected by the addition of titanium, which brings about a dispersion of particles of titanium carbide. Nichrome is also improved from the point of view of creep resistance by the precipitation of a complex intermetallic compound of nickel, titanium and aluminium.

An iron–nickel alloy with 36 per cent of nickel and 5–8 per cent of chromium, together with a certain

amount of titanium, has been developed where low thermal expansion, as, for example, in a tuning fork, is required. The magnetic properties of iron–silicon alloys used in transformers, etc., have been shown to be effected by the crystalline orientation of the grains. Better magnetic properties are found in a direction parallel to the edges of the cube than in any other, and a technique has been worked out to ensure that this orientation is, at any rate, largely obtained.

Another example of the development in magnetically soft material are the 'dust-cores' used in transformers and inductances for telecommunication work. Here, a constant permeability is desired. A reduction in the size of the particles greatly reduces the effective permeability, but stabilizes its value for different magnetic fields as well as reducing the loss due to eddy currents. A carbonyl iron in the form of spherical particles a few thousandths of a millimetre in diameter has been produced in Great Britain for the purpose.

Passing on to the magnetically hard materials, the enormous advances which have been made in this field were outlined; the value with some alloys of applying during the cooling a magnetic field which produces a large increase in the remanence in the direction of the applied field was pointed out. Here, as in the case of the anisotropic silicon-iron, it is important that the design should be such that the material is used in the favourable direction only.

In conclusion, what may be an extremely important development in cast iron was mentioned. This, in brief, is the treatment of the iron in such a way that the graphite formed is of the nodular type characteristic of black-heart malleable iron, which hitherto has only been possible after lengthy heat-treatment.

F. C. T.

THE *ZOOLOGICAL RECORD*

THE appearance of volume 81 of the *Zoological Record*, dealing mainly with the literature of 1944, is worthy of special notice, for this comprehensive bibliography of zoological literature has been published regularly since its foundation in 1864. The *Record* is still mainly dependent on donations for its production, and until the Zoological Society of London assumed responsibility for its publication it underwent many changes in its direction which might have had a disastrous effect on a less hardy annual.

The object of the *Record* is to give a reference to every article or book of zoological importance throughout the world that has appeared in the previous year. During the War it was impossible to bring out the volumes to time, and at the moment there is a delay of nearly two years; but as soon as printing conditions are easier it is hoped to get back to the normal practice of completing the *Record* in the year following the literature to which it refers. The cost of producing such a work is, of course, far beyond the price at which it is sold, and it could scarcely hope to be self-supporting; but a further measure of support might be expected from professional zoologists, some of whom seem to be unaware of its existence. The complete volume, published at £4 (subscription rate £3 5s.), is more suitable for libraries, university departments, etc.; but the sections are issued separately as soon as they are ready, and since their cost ranges from only 2s., in the case of the smaller groups, to 6s. for Aves, and a maximum of 15s. for Insecta, it should be possible for any zoologist to provide himself with the literature of the group in which he is specially concerned.

There is a mistaken impression that the *Zoological Record* is only of interest to the systematist, but it is also invaluable to the comparative anatomist, the embryologist and the field naturalist; and publications concerned in a general way with genetics, ecology, and other branches of zoology are also included.

Each reference is allotted to one of the twenty odd sections into which the *Record* is divided, and then dealt with under three headings: (1) Titles, containing complete references to all articles arranged in alphabetical order of the authors' names; (2) Subject Index, giving a detailed analysis of the subjects dealt with in each article; and (3) Systematic Index, comprising a list of all the animals referred to in the section concerned, including those described as new forms, arranged in systematic order. This arrangement enables the reader to find the information regarding the current zoological literature of any group under the authors' names, under specific subjects, or under the scientific names of animals.

The nature of the service provided by the *Zoological Record* is illustrated in the following excerpt:

I. TITLES.
66.—CHRISTENSEN, J. F. The oocysts of coccidia from domestic cattle in Alabama (U.S.A.), with descriptions of two new species. *J. Parasit.* Urbana, **27**, 1941, pp. 203–220. 2 pls. 1 text fig.

II. SUBJECT INDEX.
STRUCTURE.
SPOROZOA.
Eimeria spp. (including new) from American cattle, CHRISTENSEN, **66**.
ECOLOGY.
PARASITISM: Hosts—
MAMMALIA: *Bos taurus*, intestine (U.S.A.): *Eimeria alabamensis* spp.n., *E. subspherica* spp.n. (Sporoz. Coccid.). CHRISTENSEN, **66**.
ECONOMICS.
COCCIDIOSIS: Coccidiosis in U.S.A. cattle. CHRISTENSEN, **66**.

III. SYSTEMATIC INDEX.
4. SPOROZOA. (b) COCCIDIIDA.
Eimeria alabamensis, *E. subspherica* spp.n. (with key to other spp.) from cattle, U.S.A. CHRISTENSEN, **66**.

It should be emphasized that donations to the *Zoological Record* are still quite inadequate, and further support is urgently required from institutions and individuals.

EDWARD HINDLE

FORTHCOMING EVENTS

Tuesday, September 2—Tuesday, September 9

WORLD POWER CONFERENCE (at The Hague, Holland).—Conference on "Fuel Economy".

Friday, September 5

INSTITUTE OF ECONOMIC ENGINEERING (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Colonel Bernard Ungerson: "Personnel Selection: Army Experience in its relation to the Problems of Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER-IN-CHARGE, CHEMISTRY DEPARTMENT, in the Technical Education Branch of the Department of Public Instruction, Sydney—The Official Secretary, New South Wales Government Offices, 56–57 Strand, London, W.C.2 (September 5).

LECTURER IN PHYSICS—The Secretary, University Offices, 38 North Bailey, Durham (September 6).

ASSISTANT LECTURERS IN PHYSICAL GEOGRAPHY, and an ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College of Wales, Aberystwyth (September 6).

LECTURER IN CHEMISTRY, and a LECTURER IN PHYSIOLOGY—The Principal, Central Technical College, Suffolk Street, Birmingham (September 6).

ASSISTANT LECTURER IN PHYSICS in the Bradford Technical College—The Director of Education, Town Hall, Bradford (September 6).

CHAIR OF COMPARATIVE PHILOLOGY at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 10).

CHAIR OF CIVIL ENGINEERING in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 12).

SENIOR BIOCHEMIST at the Teaching and Research Laboratory in the Maudsley Hospital Post-Graduate Medical School—Prof. S. Nevin, Training and Research Laboratory, Maudsley Hospital, Denmark Hill, London, S.E.5 (September 13).

LECTURER IN NATURAL PHILOSOPHY in University College, Dundee—The Secretary, The University, St. Andrews (September 13).

ASSISTANT LECTURER IN AGRICULTURAL ZOOLOGY—The Registrar, The University, Leeds 2 (September 15).

RESEARCH FELLOWSHIP IN MEDICAL PHYSICS, and a LECTURER IN TOWN AND COUNTRY PLANNING—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

SENIOR ECONOMIST—The Secretary, Agricultural Economics Research Institute, Parks Road, Oxford (September 15).

LECTURER IN GEOGRAPHY in the University of Ceylon—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 20).

PROFESSOR OF ANATOMY, a PROFESSOR OF BIOCHEMISTRY, a PROFESSOR OF BACTERIOLOGY, a PROFESSOR OF PARASITOLOGY, a PROFESSOR OF PATHOLOGY, and a PROFESSOR OF SOCIAL MEDICINE AND HYGIENE, in the King Edward VII College of Medicine, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 20).

SCIENCE GRADUATES with qualifications in Geology and/or Physics, especially Geophysics, for the New Zealand Geological Survey—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 20).

PRINCIPAL LECTURERS, SENIOR LECTURERS, and LECTURERS, IN BALLISTICS, MECHANICS, MACHINES, MATERIALS AND STRUCTURES, HEAT ENGINES, ELECTRICAL ENGINEERING, at the Military College of Science, Shrivenham, Wilts—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1965 (September 25).

RESEARCH ASSISTANT IN THE BIOCHEMICAL DEPARTMENT, and a STATISTICIAN to assist in the design of nutritional experiments and undertake analysis of the resulting data—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (September 25).

SAFETY OFFICER at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting D.239/47A (September 27).

ASSISTANT ELECTRICAL ENGINEER at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting D.240/47A (September 27).

CHAIR OF VETERINARY SCIENCE in the University of Ceylon—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 30).

LECTURER IN MATHEMATICS at the University of Tasmania—The Agent-General for Tasmania, Golden Cross House, Charing Cross, London, W.C.2 (September 30).

SENIOR LECTURER IN STRUCTURAL ENGINEERING at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 30).

CHEMISTS (men and women) of Degree standard for temporary posts in the grades of Senior Scientific Officer, Scientific Officer, Senior Experimental Officer, and Experimental Officer, in the Chemical Inspection Department, Ministry of Supply, for service in North-West England—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.694/47A. (September 30).

DIRECTOR OF RADIO RESEARCH in an enlarged Radio Research Organisation to be established by the Department of Scientific and Industrial Research in extension of its present work in the Radio Division of the National Physical Laboratory and elsewhere—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1967 (September 30).

LECTURER (Grade IIc) IN CHEMICAL ENGINEERING, a RESEARCH FELLOW for fundamental work on the oxidation and constitution of coal, and a RESEARCH SCHOLAR for fundamental work on the oxidation and constitution of coal—The Secretary, The University, Edmund Street, Birmingham 3 (October 1).

REGIUS PROFESSOR OF MATERIA MEDICA AND THERAPEUTICS at the University of Glasgow—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (October 8).

CHAIR OF CHEMICAL PATHOLOGY, SENIOR ASSISTANTS (one in BACTERIOLOGY and one in PATHOLOGY), and a SENIOR LECTURER IN PATHOLOGY, in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 14).

PROFESSOR OF PHILOSOPHY—The Secretary and Registrar, University College of North Wales, Bangor (October 31).

SENIOR LECTURER IN HORTICULTURE in Canterbury Agricultural College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 31).

LECTURER IN STATISTICS AND ECONOMICS at the University of Tasmania—The Agent-General for Tasmania, Golden Cross House, Charing Cross, London, W.C.2 (October 31).

JUNIOR LECTURER IN ZOOLOGY, and a TECHNICIAN IN THE DEPARTMENT OF ZOOLOGY, at the Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 31).

MEDICAL GRADUATES for (*a*) research on the pathology of schistosomiasis in man and experimental animals (mainly abroad), and (*b*) the clinical care of patients at the Field Research Station, Gambia, to undertake nutritional and other investigations—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

SENIOR LABORATORY STEWARD for chemical laboratories—The Bursar, The Alington Hall, The Schools, Shrewsbury.

RESEARCH ASSISTANTS (2) IN THE CYTOLOGY DEPARTMENT in the Senior Scientific Officer, Scientific Officer and Assistant Experimental Officer grades, and a LIBRARIAN (woman) with interest in scientific research—The Director, John Innes Horticultural Institution, Merton, London, S.W.19.

ASSISTANTSHIP IN ENTOMOLOGY in the Department of Agriculture and Forest Zoology—The Secretary, The University, Edinburgh.

RESEARCH DEMONSTRATOR IN BOTANY AND ZOOLOGY in the Department of Biology—The Registrar, University College, Singleton Park, Swansea.

PHYSICISTS to carry out investigations on the physical properties of leather, CHEMISTS to carry out investigations on (*a*) the organic chemistry of the vegetable tannins, (*b*) the processing of leather and elucidation of tannery problems, and a BIOLOGIST to work mainly on the micro-biological problems of the industry—The Director of Research, British Leather Manufacturers' Research Association, 1–4 Nelson Square, London, S.E.1.

LABORATORY ASSISTANT IN THE DEPARTMENT OF BIOCHEMISTRY—The Establishment Officer, University College London, Gower Street, London, W.C.1.

LABORATORY ASSISTANT to take charge of CHEMISTRY DEPARTMENT—The Bursar, The College, Cheltenham.

EXPERT IN SOAP MANUFACTURE, Department of Commerce and Industries, Government of Ceylon—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17602.

LABORATORY TECHNICIAN (Grade B) with general experience in clinical pathology, at St. Margaret's Hospital, Stratton St. Margaret, Swindon—The County Medical Officer, County Hall, Trowbridge, Wilts.

LECTURER IN RADIO ENGINEERING—The Clerk, Northern Polytechnic, Holloway, London, N.7.

SIR JESSE BOOT CHAIR OF CHEMISTRY—The Registrar, University College, Nottingham.

GRADUATE LECTURER IN MECHANICAL ENGINEERING SUBJECTS at the Lincoln Technical College—The Director of Education and Clerk to the Governors, City Education Offices, 4 Lindum Road, Lincoln.

SENIOR LECTURER IN EDUCATION in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

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Proceedings of the California Academy of Sciences, Fourth Series. Vol. 25, No. 16: Alice Eastwood Semi-Centennial Publications, No. 16, Endemism in the Hawaiian Flora, and a Revision of the Hawaiian Species of *Gunnera* (Haloragidaceae). By Prof. Harold St. John. (Hawaiian Plant Studies, 11.) Pp. 377–420 (plates 37–46). Vol. 25, No. 17: Alice Eastwood Semi-Centennial Publications, No. 17, A Revision of the *Artemisia vulgaris* complex in North America. By David D. Keck. Pp. 421–468. Vol. 25, No. 18: Alice Eastwood Semi-Centennial Publications, No. 18, The Genus *Ruppia* L. By William A. Setchell. Pp. 469–478 (plates 47–48). (San Francisco: California Academy of Sciences, 1946.) [125]

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